Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

SEPTEMBER 1955

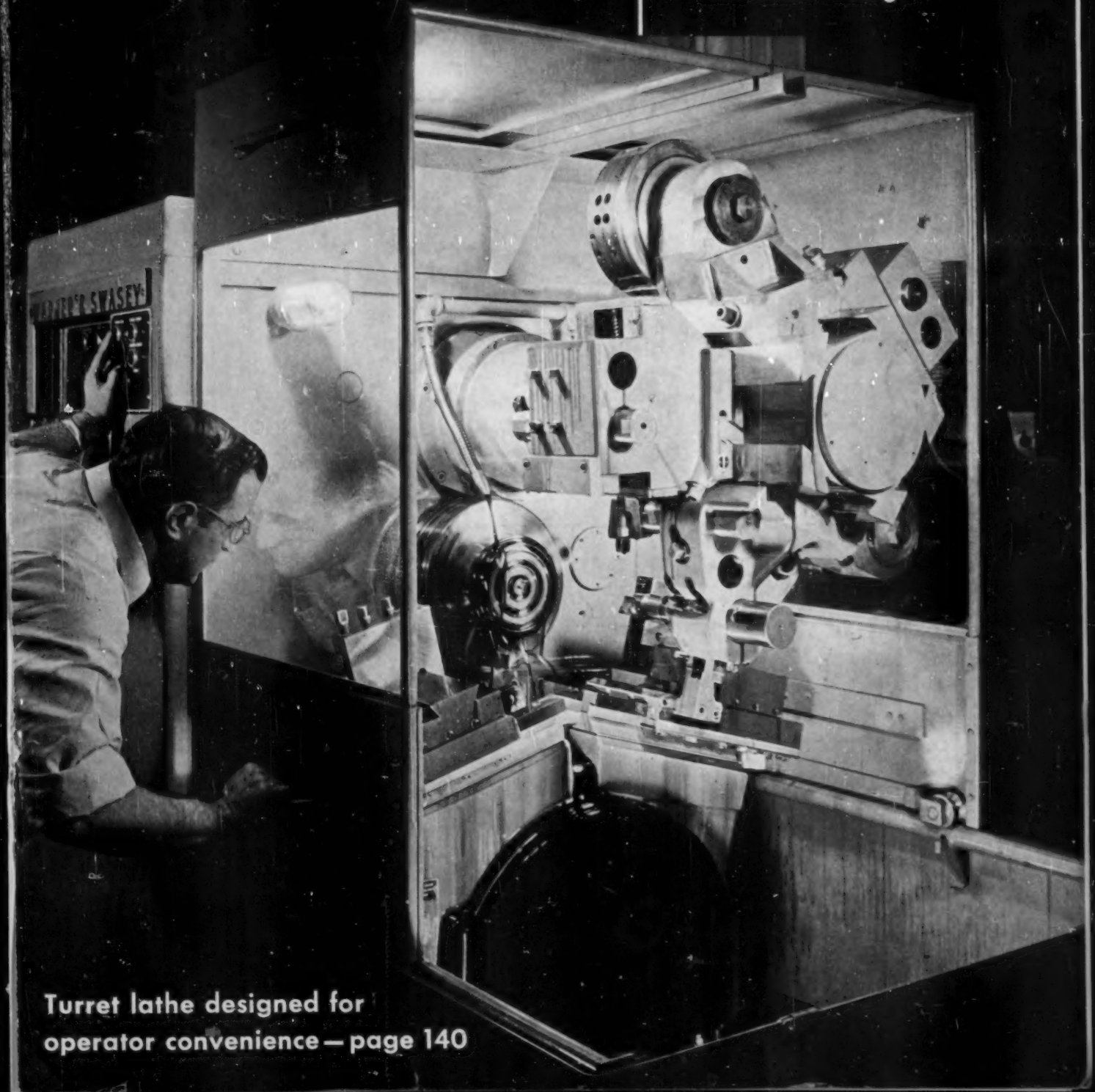
What users want in

Machine Tool Control

Human Dimensions

Pancake Motors

Plate Cam Design



Turret lathe designed for operator convenience—page 140

Boot for 24 feet

ADDS MILES OF LIFE TO A BIG LIFT

It's a lot of boot . . . 36″ outside diameter and extended length of 24 feet. Designed and built by Chicago Rawhide, this boot protects the main plunger . . . saves downtime . . . on the scrap hoist in an open hearth mill. Made of synthetic rubber coated fabric, it effectively excludes dirt, and all foreign matter . . . prevents scoring and abrasion on this giant ram. Design of this boot permits quick, easy installation . . . without dismantling the hoist.

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Double Solenoid Direct Operated

Solenoid Introld (Pilot Operated)

Hand Operated

Solenoid Direct Operated

Retrold (Remote Controlled) TD, Sequence Type

Pilot Valve

Solenoid Introld (Pilot Operated) Momentary Contact

Hand Operated

Solenoid Introld (Pilot Operated) Safety

Cam Direct Operated

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- *Prevent leakage*
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ROSS Control VALVES

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REVERE
90-10 Cupro-Nickel *helps protect aviation gasoline*

Arc welding of the Filter/Separator.

Gasoline Filter/Separator made by Bendix-Skinner Division almost entirely of Revere 90-10 Cupro-Nickel.

It has been found that minute traces of water in aviation gasoline can stop the engine when flying in low temperatures, as at high altitudes, or over the pole. The amount of water involved is so small that it would not bother an automobile carburetor. To remove it for safe flying requires a special Filter/Separator. All metal parts going into this filter were specified to be 90-10 Cupro-Nickel. One of the contractors for the U. S. Navy is the Bendix-Skinner Division of the Bendix Aviation Corporation, Royal Oak, Mich. When Bendix-Skinner obtained the order, it called in Revere's Technical Advisory Service. A complete study was made of the blueprints and specifications, in order to set up the most economical purchasing schedules. When production began, personnel from the Welding Section of the Research and Development Laboratory maintained by Revere in Rome, N. Y., went to the Bendix-Skinner plant to share their know-how with the welders, so as to be sure the welds would pass strict inspection, yet be made at competitive costs.

Cupro-Nickel, 90-10, is highly resistant to corrosion and other forms of attack. Because it contains only 10% nickel, it is more economical than the richer alloys, yet in many applications just as satisfactory. We suggest you look into it.

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Product Engineering

SEPTEMBER 1955 Vol. 26 No. 9

The McGraw-Hill Magazine of Design Engineering

Axial-Air-Gap Motors for Machine Tool Drives ..... John Merriell **129**
How construction and performance differ from conventional motors; data on reductions in weight and length, and increased rotor inertia and acceleration time.

Alloy Plating ..... Robert T. Gore **136**
Recent developments offering new combinations of properties; characteristics and applications for a copper-tin alloy with exceptional throwing power and high deposition.

Product Designs **140**
Four new and significant developments in machine tool design: turret lathe designed for operator convenience; card-controlled turret punch press; sparkgap tracer control; high-speed spindle screw machine. Also, synchronized hydraulic lift, safety features in new rifle.

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Human Dimensions ..... Robert H. Hose **166**
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Invaluable Reference Data on . . .

High Density Metal

In counterweights, high inertia rotors and radioactive shielding, the unique properties of Mallory 1000 Metal offer exceptional opportunities for product improvement. To help designers in the use of this unusual metal, Mallory has compiled all current technical data on characteristics and applications into the latest edition of the Technical Bulletin on this subject.

Its 12 pages are full of information never previously published in a single catalog. Presented in convenient tabular and graphic form are extensive data accumulated by Mallory's own research and by organizations who are now applying this versatile material. Among the subjects covered are—

A complete listing of physical properties
Properties at elevated temperatures . . . expansion, fatigue, tensile properties
Radiation shielding data . . . tenth layer thickness up to 10 Mev, absorption for various isotope radiation
Permissible rotation speeds of rotor rings

Completing the publication is a discussion of the excellent corrosion resistance of Mallory 1000, and recommendations for machining and joining. Altogether, the Bulletin constitutes a valuable reference on a metal that you will be able to apply advantageously in many different products. Write to Mallory for a copy today.

USE MALLORY 1000 METAL FOR —

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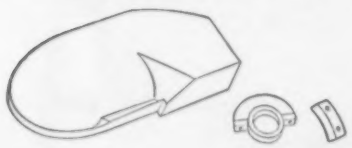
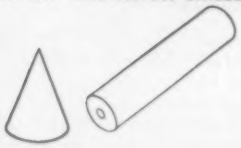
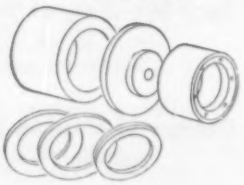


EFFICIENT RADIATION SHIELDING



STABLE ROTORS



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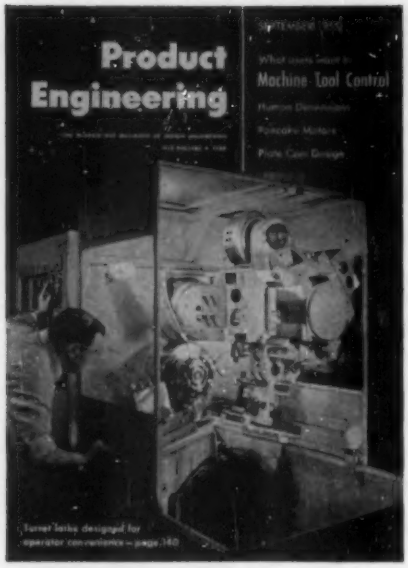

THIS MONTH'S COVER

Elimination of every time-consuming set-up adjustment and design of controls for operator convenience were major objectives behind the development of Warner & Swasey's new 2AC single-spindle chucking machine. See articles starting on pages 140 and 166 for story of machine and data on human dimensions.

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Developments

To Watch

THE EFFECT OF GRINDING ON STEEL. . . .

. . . .is being studied by the Mellon Institute, Pittsburgh 13, Pa. in conjunction with two other laboratories. Results of a preliminary phase of the investigation show that compressive stresses, in some cases as high as 100,000 psi, can be developed in the surface of quenched and tempered ball bearing steel by abrasive wheel grinding. Directly beneath the compressive layer is a layer of tensile stresses, the amount of which is dependent upon the grinding conditions. By increasing the unit downfeed, higher tensile stresses and thicker stressed layers result. The effect of the wheel grade is not large, but stresses in the tensile layer are highest for wheels in the medium hardness range. It was found that by using grinding fluids, large differences in residual stresses result. Further study will reveal the effect of grinding severity upon fatigue life.

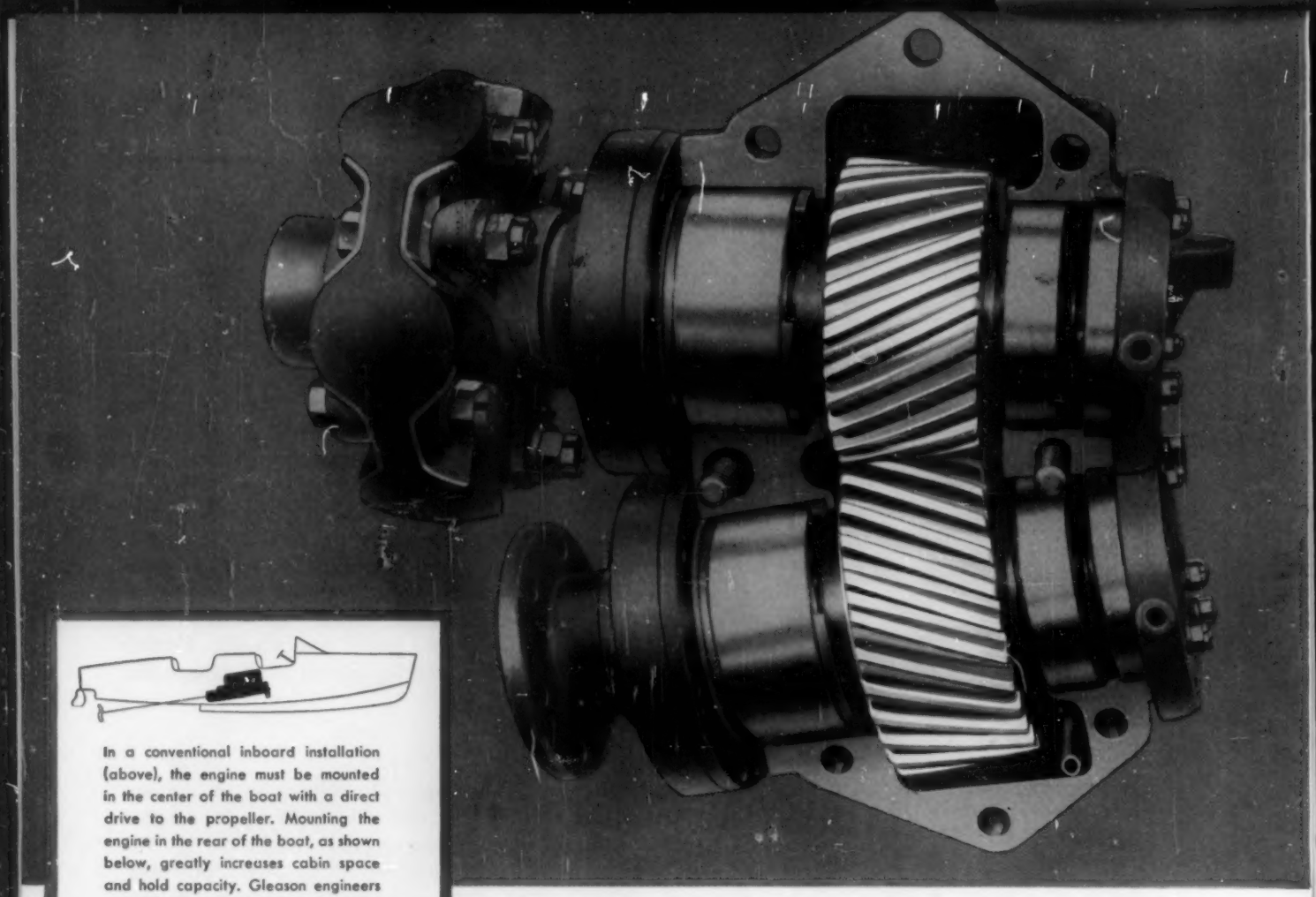
A FOAM PLASTIC SPHERE. . . .

. . . .measuring 36 in. in diameter and weighing 42 pounds, was shown recently by the Naval Research Laboratory, Washington 25, D. C., and is said to be the largest plastic sphere made. The sphere was made in two halves, glued together, coated with a fiberglass coating and a yellow-pigmented epoxy resin to protect it from sea water. Ultimate use was to buoy 800 pounds of instruments used in a special test. The foam-plastic used was Koppers Company's expandable polystyrene which has a density of 1½ lb per cu foot. NRL was able to increase this to 3 lb per cu ft by injecting steam (necessary for the chemical reaction) through small holes in the side of the mold, and through a net-like arrangement of aluminum tubing embedded in the plastic. Weighing only 2½ lb in each half sphere, the tubing did not greatly effect the final weight. Several other removable steam probes were also used. Although the sphere was made in two halves, NRL says that it can be made in one piece. Six spheres have been made at a total cost of $1,250 including labor and materials.

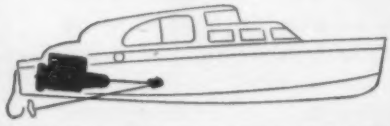
INTERRUPTING CURRENTS UP TO 5 AMPERES. . . .

. . . .for periods as short as one microsecond is possible with an electronic switch developed by the Stanford Research Institute, Menlo Park, Calif. for use in their work on the plating of titanium. In this interval, it is possible to measure, without current flowing, the polarization voltage before it has time to decay to zero. Such measurements give the inherent voltage drop of a given bath and the rate at which the polarization voltage falls, to what it eventually becomes with no current-flowing supplements. Work is also being done with ultrasonic vibrations in the "strike" bath in attempts to throw off the oxide on titanium before the plating metal strikes, thereby getting a stronger bond.

(continued on page 7)



In a conventional inboard installation (above), the engine must be mounted in the center of the boat with a direct drive to the propeller. Mounting the engine in the rear of the boat, as shown below, greatly increases cabin space and hold capacity. Gleason engineers assisted the Marine Engine Manufacturers in the development of the V-Drive.



Angular power transmission can improve *your* product, too

Take, for example, this marine V-Drive. The use of spiral bevel gears permitted a design which released more usable space in the boat, improved balance, and simplified installation.

This is just one instance of the added flexibility of product design possible with angular power transmission.

Faster production and lower costs will also result from using this type of transmission.

If you have a design application for bevel or hypoid gears, the Gear Engineering Department of the Gleason Works is ready to help you realize every advantage possible. Design and production recommendations for your angular drive are offered at no obligation.

If you would like to discuss your bevel gear application with a Gleason representative, please contact us.

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Developments to Watch

AN ENAMEL COAT APPLIED DIRECTLY TO FERROUS METALS. . . .

. . . .has been found to give improved physical characteristics as well eliminating the costly and time-consuming ground coat and nickel flash steps. The key to the new method is a new material, Pre-Namel 410, developed by the Parker Rust Proof Co., Detroit, Michigan. Tests have shown that the process has produced: a reduction of the coating thickness with a consequent reduction of damage from cross-bending; straighter parts with less bowing; and a reduction in the number of enamel frits required. The process also applies to cold rimmed steel and enameling iron; and permits the application of standard finish coat porcelain enamels direct to steel. Savings are said to be from one to three cents per square foot of surface area enameled. Application of the material may be done with automatic equipment.

THE NAVY'S USE OF PLASTICS. . . .

. . . .is on the increase according to a recent report from The Manufacturing Chemists Association. The big reason is that the change means dollar savings all along the line. Specifically, the Navy expects to use reinforced plastic drums in place of steel in the procurement of bleach; also, reinforced plastic for fresh water tanks and oil storage, replacing scarce monel and aluminum bronze. Plastic is replacing copper or galanized metals for screening applications; expanded polystyrene for sheet metal buoyancy tanks in life boats; and maybe all plastic life boats. A new plastic electrical fitting is replacing metal.

HIGH STRENGTH METAL PARTS. . . .

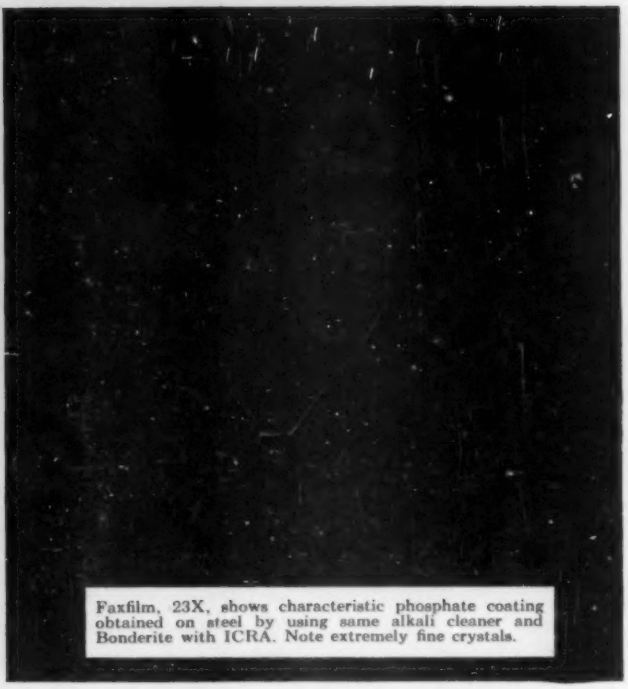
. . . .with either enlarged ends or central sections can be made by "metal gathering", a process being used by Thompson Products, Inc., Bell, Calif. The process differs from upsetting in that the length of stock which can be accumulated in the gathered mass is theoretically unlimited. The unsupported length of material which can be upset is about 2.5 times the smallest diameter of the tubing or bar. In metal gathering, a hydraulic ram feeds stock into the "gather zone" through a split upper contact which serves as one of the two electrodes, and rests upon a lower platten which serves as the second electrode. Passing a current between the two electrodes heats the metal to a plastic state. Pressure applied to the hydraulic ram forces the metal into the desired shape. Metals which can be fabricated by this process include tin, titanium, aluminum (14S), and alloy and stainless steels. Titanium alloys can be gathered as easily as stainless steels.

OIL AND GREASES WILL NOT WORK AS LUBRICANTS. . . .

. . . .for the moving parts in the water-cooled nuclear section of atomic power plants, according to reports from the Argonne National Lab., Lemont, Illinois. It was learned that organic lubricants react chemically under irradiation, and that quantites of a lubricant depositing on the fuel elements would impede the heat transfer. Conditions are such that it is necessary that a bearing material be found which would permit the use of cooling water as a lubricant. This is required despite the fact that corrossion is a problem, and the temperature of the cooling water ranges from 200 to 500 F. On sliding type bearings, graphite materials were found to be the only ones suitable for high speeds and loads up to 100 psi, provided the journal material was compatible with carbon. Titanium carbide proved superior to other materials when used with carbon.

(*Continued on page 9*)

Faxfilm, 23X, shows characteristic phosphate coating obtained on steel by using conventional alkali cleaner followed by phosphating material without ICRA. Note size of crystals.



Faxfilm, 23X, shows characteristic phosphate coating obtained on steel by using same alkali cleaner and Bonderite with ICRA. Note extremely fine crystals.

New Bonderite 800 series contains I C R A

(INTERNAL CRYSTAL REFINING AGENT)

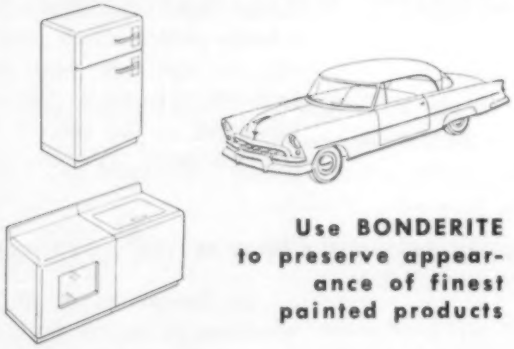
Built-in improved performance!

In the new Bonderite 800 Series, Parker presents a great new development in zinc phosphate coating. ICRA—Internal Crystal Refining Agent—produces a denser coating with finer crystalline structure. Use it on steel surfaces, and on zinc surfaces such as galvanneal, zinc base die castings, and electrogalvanized in mixed production with steel.

The very smooth, continuous phosphate surface produced by 800 Series Bonderites makes for exceptional evenness of paint penetration, with greater uniformity of paint luster. Metal coated with 800 Series Bonderites may be rubbed, bent or flexed without loss of coating bond. This means better adhesion of paint, also.

Many types of Bonderite with ICRA are available in the 800 Series. You can choose the one best suited to your needs as to method of application, processing time and temperature, and coating weight.

Get full information on Bonderite 800 Series with ICRA. Call or write today.



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Developments to Watch

A MIRROR-LIKE INSIDE SURFACE FINISH. . . .

. . . .on cold-drawn electricweld steel tubing is being offered by the Jones & Laughlin Steel Corp., Tube Div., Oil City, Pa. The tubing is being used extensively in hydraulic and pressure cylinders, and is said to have a surface finish better than some honed finishes. Close control of both inside and outside tolerances are maintained by drawing the tubing over a mandrel and through a ring die simultaneously. Minimum tensile strengths are 70,000 psi, and yield strengths up to 65,000 psi depending upon the size of the tubing and carbon content. The tubing has a high weight-to-strength ratio, and can carry heavy torsion loads. O.D. sizes range from ¾ to 2¼ in., wall thicknesses range from 0.035 in. minimum to 0.134 in. maximum.

ANNEALED ALLOYS WITH LOW COEFFICIENTS OF EXPANSION. . . .

. . . .have been investigated at various temperatures between —65 and +950C. The cobalt-iron-chromium alloys were used, and alloys of about 54 per cent cobalt, 36.6 per cent iron, and 8.9 per cent chromium showed coefficients of expansion less than 1×10^{-6} per deg C for the range from 20 to 60 C. For temperatures above 60 C, the coefficients of expansion jumped to about 16×10^{-6} per deg C for the range from 250 to 300 C. Close control of the chemical composition is necessary for the production of these low expanding cobalt-iron-chromium alloys. It was reported that some of the alloys investigated have coefficients of expansion less than those for fused quartz and ordinary invar between —65 and +60C.

STRONGER WELDED TITANIUM JOINTS. . . .

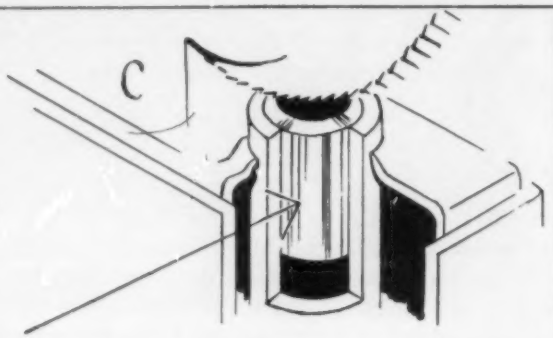
. . . .are possible with the 3A1-5Cr titanium alloy when using a pressure welding technique developed by the Menasco Mfg. Co. of Burbank, Calif. under a contract with the U. S. Naval Bureau of Aeronautics. The hot working which takes place during welding improves the weld strength without changing the microstructure. A forged butt weld using this process is said to have greater strength than that produced by other types of welds. Strength is due to the upsetting of forged surfaces under heat and pressure. So far, the method has been used for welding tubular sections of aircraft landing gear.

AND IN ADDITION. . . .

. . . .Quiet, longer wearing, and non-shrinking laminated plastic rotor vanes are responsible for the stepped-up performance of super chargers made by the Judson Research & Mfg. Co., Conshohocken, Pa.; designed for sports and pleasure cars, horsepower is increased by 40 per cent. . . . Fairchild Aircraft has plans for a light jet transport with a cruising speed of 560 mph; using four jets, the plane will have a crew of two and will carry seven passengers. . . . A fast drying, dipped or sprayed on primer for magnesium has been developed by the Stanley Chemical Co., East Berlin, Conn.; it checks electrolytic action in assemblies, and resists solvent action of hydraulic fluids. . . . Baldwin-Lima-Hamilton has completed work on a diesel driven locomotive which transmits the power directly to the driving wheels through a mechanical transmission; eliminating generators and motors, it will save strategic copper and cut weight . . . Revere Copper & Brass Co. of Rome, N. Y. is rolling 0.0015 and 0.0027 in. thick copper in widths up to 38 in. for use in printed circuitry. . . . The first experimental atomic reactor to be used by any of the branches of the Dept. of Defense will be installed in the Naval Research Lab. sometime next year; it will be of the swimming, pool type.

HOW
ARMCO 17-7 PH STAINLESS STEEL
keeps this lighter in shape

A tiny hardened Armco 17-7 PH Stainless Steel bushing is the key to dependability and long service life of a well-known lighter.



WHAT THE STAINLESS BUSHING DOES

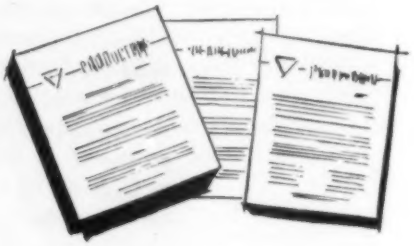
This collar in the top of the tube keeps the flint in alignment and prevents jamming. The collar must be perfectly formed and very hard. That's why it's made of Armco 17-7 PH Stainless Steel, precipitation hardened.

NO "FLOPOVER" FLINTS

In an ordinary flint tube, repeated pressure of the spark wheel against the flint causes the end of the tube to expand. This permits the flint to "flop over," making the lighter useless.

WHAT THIS STEEL OFFERS YOU

Consider the advantages of Armco 17-7 PH Stainless Steel for your products. It can be drawn and formed in the annealed condition to close tolerances. Then, it can be hardened at low temperatures to tensile strengths of around 200,000 psi. It is "transformed" by holding at 1400 F for 1½ hours and cooling to 60 F or below. Hardening is completed by heating to 950-1050 F, holding for ½ to 1½ hours and cooling.



GET COMPLETE DATA

Armco 17-7 PH is produced in sheets, strip, plates, bars and wire. Besides, there is a single heat treatment precipitation-hardening stainless steel, Armco 17-4 PH, made in bars, wire and billets only. For complete information on these special Armco Stainless Steels, just fill out the coupon and mail it to us.

ARMCO STEEL CORPORATION
1585 CURTIS STREET, MIDDLETOWN, OHIO

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ARMCO STEEL CORPORATION, 1585 Curtis Street, Middletown, Ohio

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Street:_____

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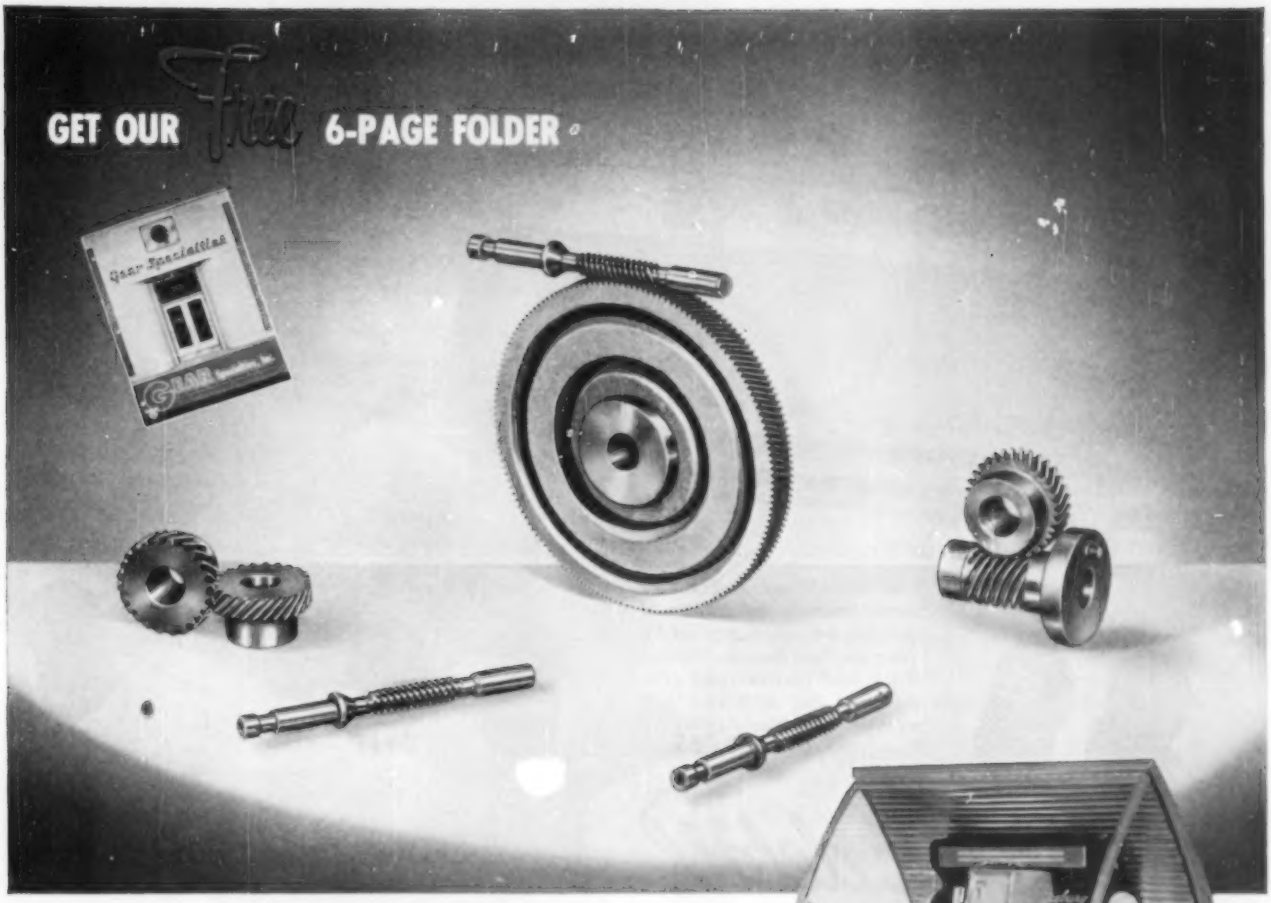
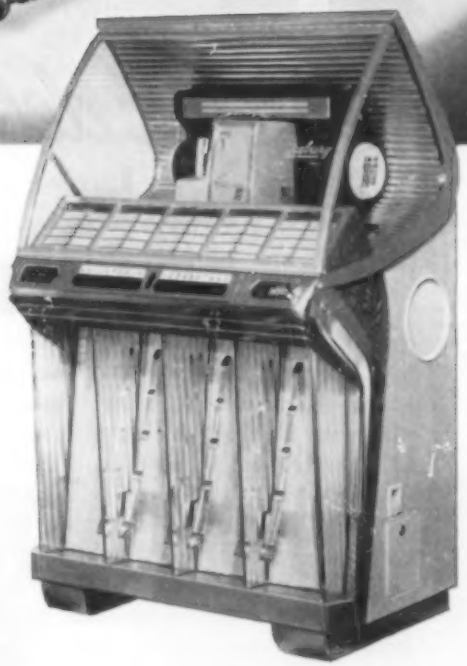


G. S. Gives SEEBURG
Consistently Better Small Gearing

SEEBURG Automatic Musical Instruments have gained an enviable reputation for high fidelity and *dependability*. Listeners marvel at their crisp, clear, *impressive* tone. Owners like the almost uncanny ability of a SEEBURG to perform without interruption day in and day out *for YEARS!* G. S. Small Gearing has long made important contributions to the remarkable performance record of fine SEEBURG automatic mechanisms. ★ If *top quality* Small Gearing from 8 to 96 dp is an important consideration in YOUR business, specify G. S.! Get Gearing that *consistently* speeds production, cuts costs, and meets the most exacting specifications.



SEND FOR.. our 6-page Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course.

40 Years of Specializing in Small Gearing!

FRACTIONAL HORSEPOWER GEARS

GEAR Specialties, Inc.

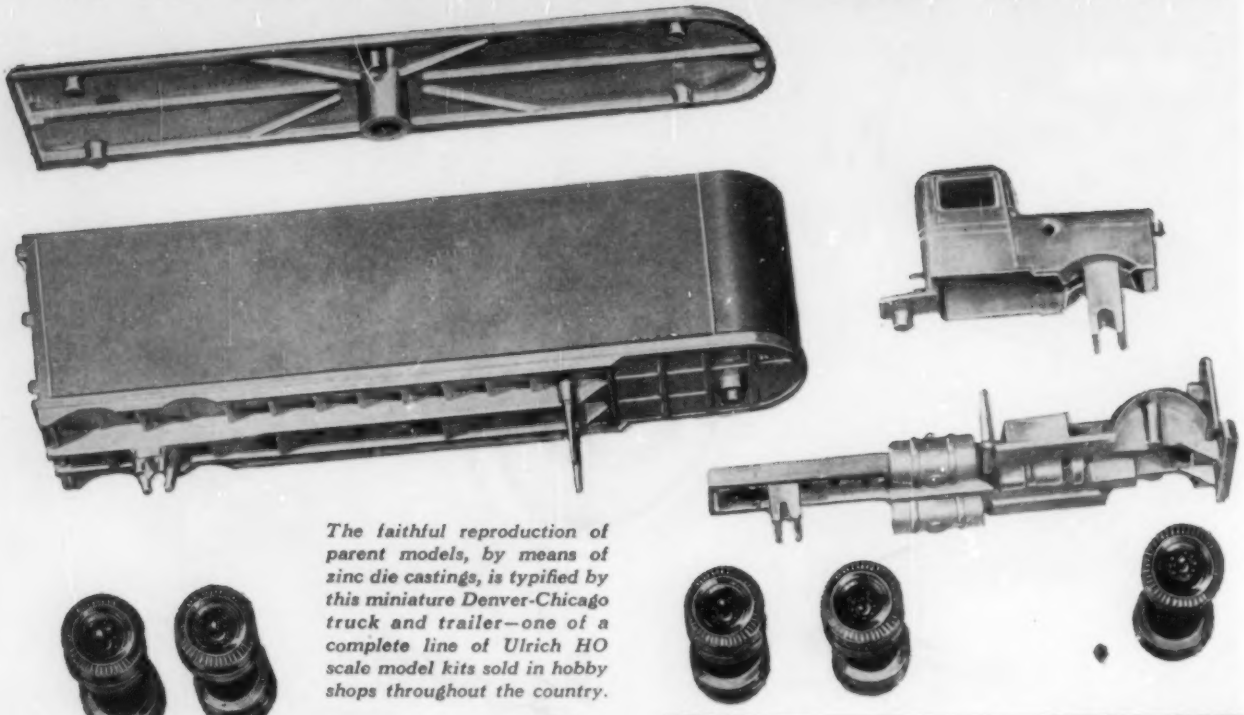
Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

WHY ZINC RATES FIRST IN DIE CASTING • NUMBER 4 OF A SERIES



The faithful reproduction of parent models, by means of zinc die castings, is typified by this miniature Denver-Chicago truck and trailer—one of a complete line of Ulrich HO scale model kits sold in hobby shops throughout the country.

clean-cut detail as featured by ULRICH

The ability to produce ZINC die castings with exacting, clean-cut detail is best illustrated by a few of the many castings employed in the scale model field. These Fruehauf trailer-truck components not only endow the Ulrich model kits with an appearance and "feel" of realism, but with extremely accurate HO scale dimensions (5/32"–1 ft.). And the ZINC die castings produced in long production runs are as alike as peas in a pod—without the need for elaborate machining.

Other ZINC die casting advantages utilized in scale model production (and in many other fields) are: *toughness*—to withstand rough usage; *smooth as-cast surfaces*—to take, and hold, any type of commercial finish; *integrally cast elements*—to provide economical and trouble-free means of assembly; *complexity of shape*—to make one part serve in place of several.

For other examples of product engineering with ZINC die castings in other fields, watch for our ads in this magazine in the months ahead. Send for our new brochure and contact any commercial die casting company regarding your particular production problems.

Send for your copy

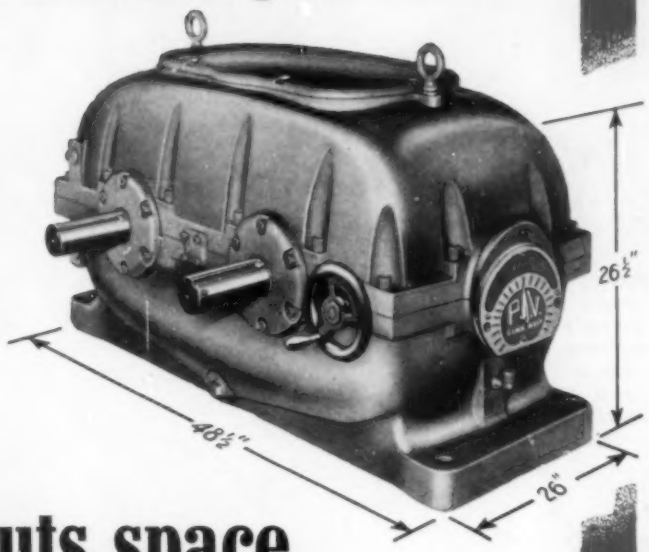
The New Jersey Zinc Company, 160 Front Street, New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

LINK-BELT 25-hp P.I.V. Variable Speed Drive



cuts space requirements up to 50%

LINK-BELT gives you all the advantages of positive, stepless speed changing in high horsepowers, too

ONE of the great advantages of P.I.V.'s positive, all-metal drive is dramatically illustrated by the Size 6. Compared to other speed changers in this hp range, it saves *70 cu. ft. of space!*

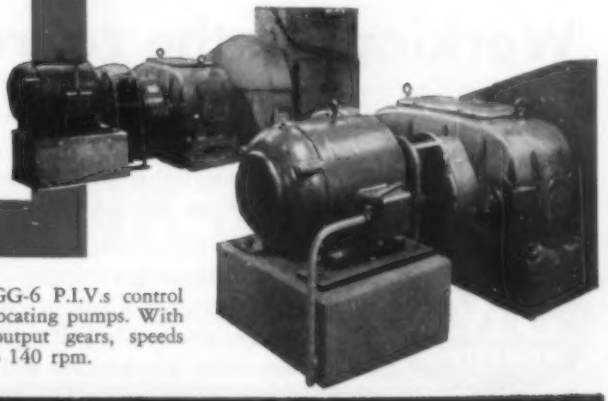
In addition, infinitely stepless regulation means you can select the exact speed you want—from maximum to minimum. Unaffected by temperature and atmospheric conditions, all moving parts are totally enclosed and splash-lubricated.

The Size 6 P.I.V. is built in three types: The basic drive . . . with input *or* output gears . . . with input *and* output gears. All are available in a wide range of ratios, 20 to 25 hp.

Get the facts on the Size 6 from your nearest Link-Belt office or distributor. You'll receive a copy of Folder 2374. And for information on the complete P.I.V. line, ask for Book 2274.

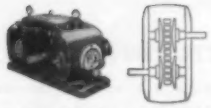
P.I.V. LINK-BELT VARIABLE SPEED DRIVE 13.594

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

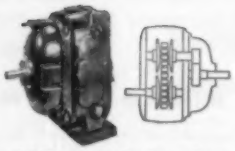


Two Link-Belt HGG-6 P.I.V.s control the speed of reciprocating pumps. With both input and output gears, speeds range from 46.5 to 140 rpm.

4 OF 16 P.I.V. TYPES
HORIZONTAL OR VERTICAL MOUNTINGS
½ TO 25 HP—
RATIOS TO 6:1

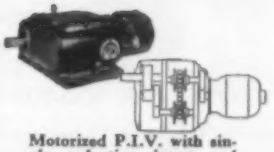


Basic, Positive, Infinitely Variable (P.I.V.) Speed Drive.



P.I.V. with single reduction input or output helical gears.

Motorized P.I.V. with single reduction input and output helical gears.



Motorized P.I.V. with single reduction input and double reduction output helical gears.

See what adhesives are doing today!

Working on the railroad–for your comfort

You can't see them. You can't hear them. But you certainly can *feel* the cool, calm, quiet comfort that 3M products contribute to the modern railroad car.

The man in the picture, for example, is making sure that the air-conditioning unit in a commuter car *keeps* its supply of pure, filtered air. He simply presses a length of 3M's reinforced ribbon sealer into position and fastens on a cover plate with screws. This accommodating sealer makes room for the screws . . . *but nothing more*. The result is a compartment that's airtight, dust-tight, just right!

Other applications for 3M adhesives, coatings and sealers in this same commuter car are numbered by the dozen. They hush noise, protect from heat and cold, stop corrosion, calm vibrations, *literally* hold parts of the car together.

See what adhesives can do for you . . .

The best news about 3M products is that, most often, they cut costs while simultaneously improving the product. And it costs nothing to investigate the possibilities in your plant. Call your 3M Field Engineer. Or write 3M, Dept. 49, 417 Piquette, Detroit 2, Mich.

3M ADHESIVES

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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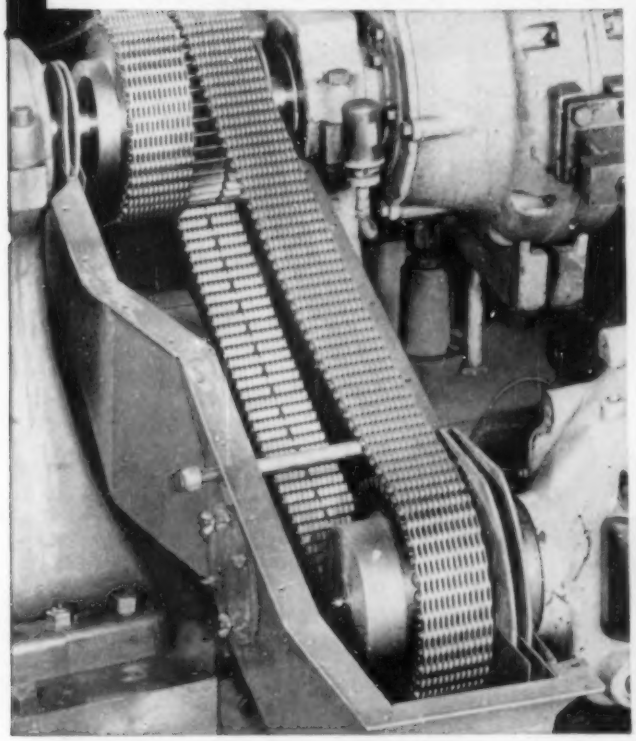
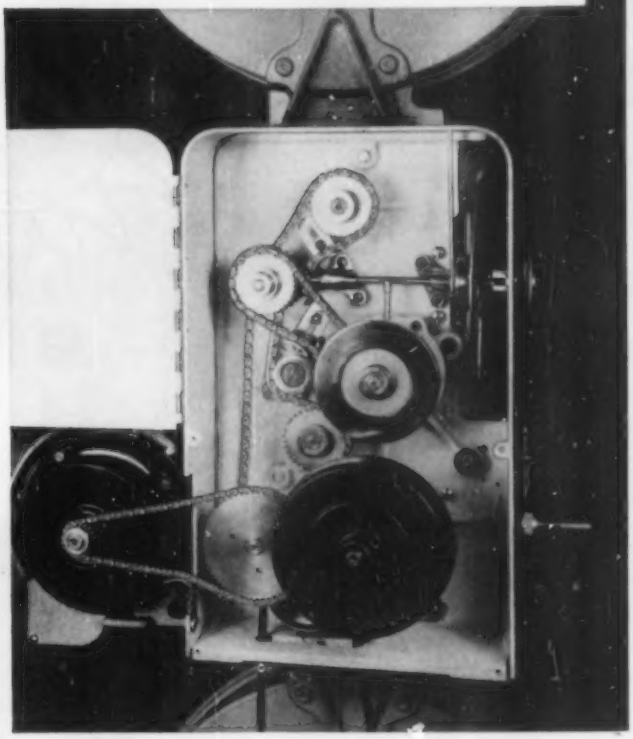
MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

For high linear speeds...



For precise timing..



No other drive does these jobs... and many more... like

Link-Belt Silent Chain

FROM transmitting high horsepowers at high speeds ... to synchronizing sound and film in a motion picture projector—Link-Belt Silent Chain has proved its superiority for a wide range of drives. Better than 98% efficiency is maintained throughout its long life —frequently 20 to 30 years or more. Positive tooth-to-tooth action provides constant ratio for full productive capacity.

And silent chain is just part of the complete Link-Belt line. You can choose from all types and sizes of cast, combination, forged and fabricated steel, roller or silent chains—with matching sprockets. Your assurance of the *right* chain for your job.

For the complete story on silent chain drives, get Book 2425. And for facts on the complete Link-Belt chain and sprocket line, send for Catalog No. 950.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,845

No ONE chain serves every purpose - - get the RIGHT one from Link-Belt's *complete* line

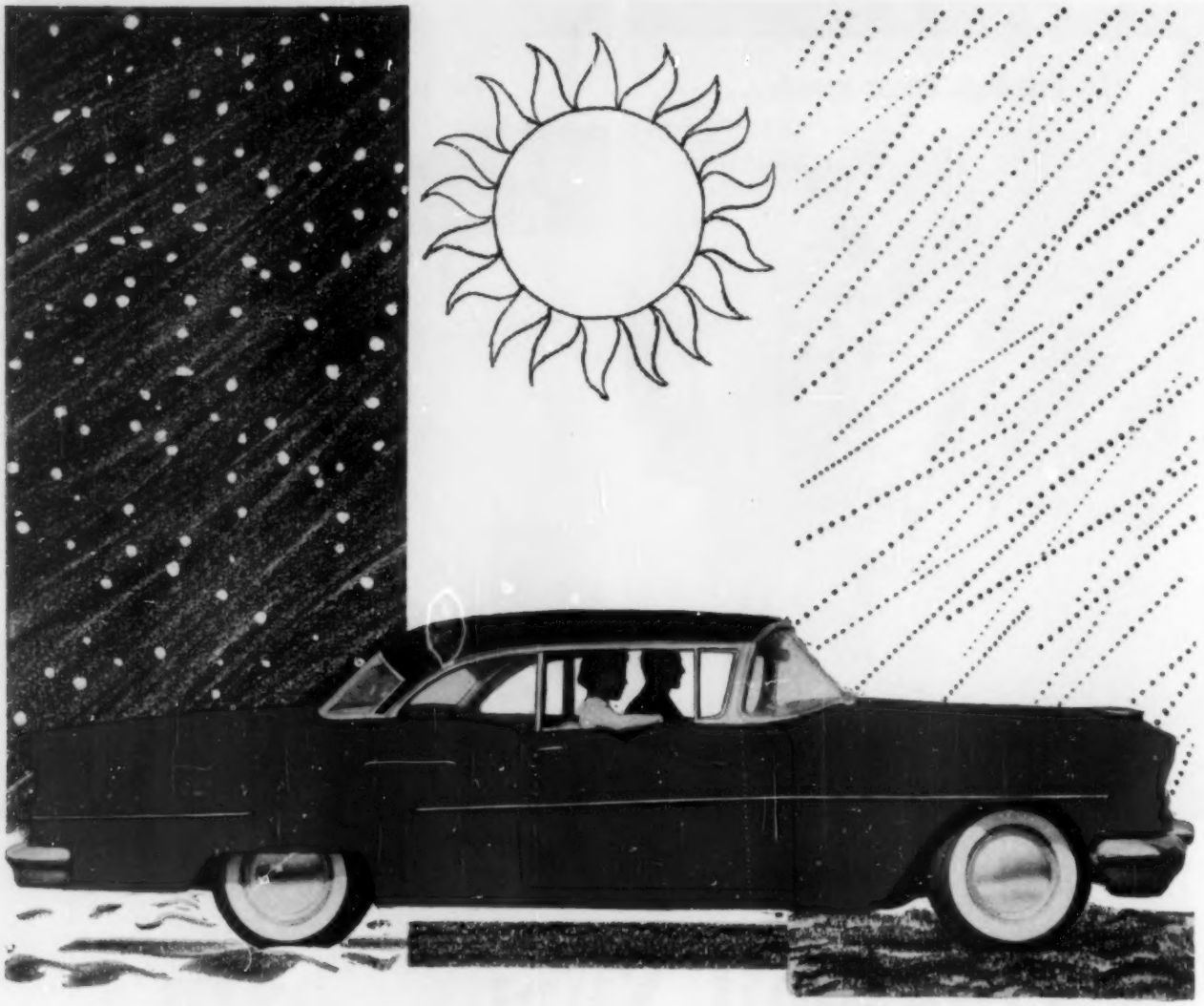
Precision Steel Roller Chain for moderate speed drives and conveyors. Available in single and multiple widths—¼ to 3" standard pitch, 1 to 3" double pitch.

LXS Steel Chains, with offset or straight sidebars, are made to close tolerances. Ideal for rugged drives, conveyors.

Detachable Link-Belt chains, available in steel, malleable or Promal, for light-strength drives and conveyors.

S-815 Flat-Top Chain—easy to detach and keep clean — one of complete line for carrying bottles, cans, cartons, cases, etc.

Complete line of single and multiple width cut tooth sprockets as well as a wide range of cast tooth sprockets.



100 parts made from Enjay Butyl give all-weather protection to new cars

In many new models, extended "new car performance" is assured in over 100 places by parts made from Enjay Butyl. This super-durable rubber has many advantages that make it amazingly resistant to the deteriorating elements that cause the early failure of most types of rubber. Its price and ready availability are advantages, too.

If you make a product in which rubber is used, or *might* be used, why not contact the Enjay Company? Our technical consultants might have very good news for you about the use of Enjay Butyl in your product. News about lower costs and higher efficiency. Why wait?

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY **ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.**
District Office: 11 South Portage Path, Akron 3, Ohio.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

Here's the Complete "Package"

for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
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Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
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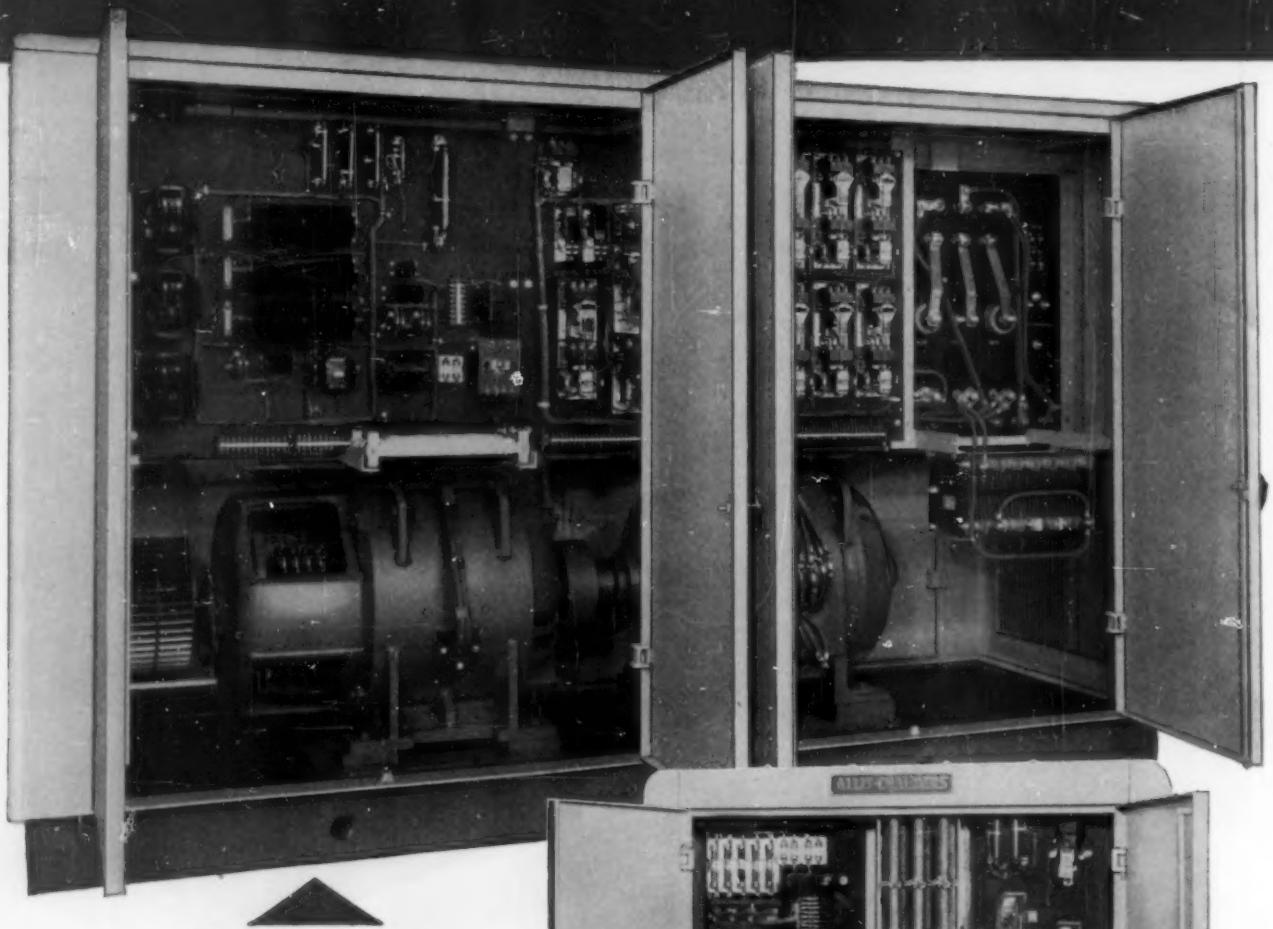
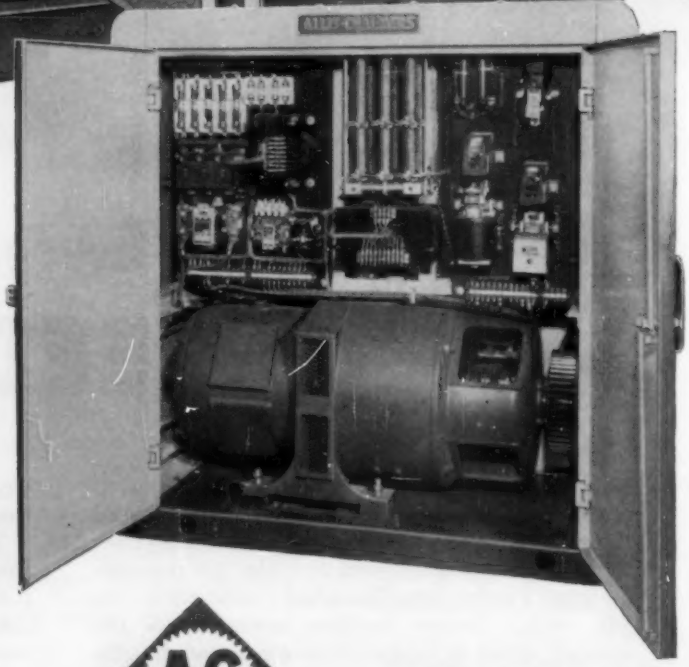
Offices and Agents in Principal Cities
"The Name that Counts"

Get the Drive

Tailored to Your Speed



A-C package drive, Size 5, 125 hp. Reversing, dynamic braking (rear view).



Size 2 packaged drive, 25 hp, with electronic speed regulation ¼ of 1% based on top speed, 3550/50 rpm.

A-C ALLIS-CHALMERS

ALLIS-

Control Needs

ALLIS-CHALMERS Package Drive Gives You

★ Wide speed range

★ Precise speed control

★ Operation from one or more points

★ Simple installation

★ Reduced maintenance

If you need speed control for up to 200 total horsepower plus special performance characteristics such as threading, jogging, dynamic braking, etc., the Allis-Chalmers package drive will provide these functions in one easy-to-specify unit. The package drive itself consists of a motor-generator set and control components mounted in a well-ventilated cabinet. Control stations and dc drive motors may be placed wherever convenient. Installation is simple because the unit is factory-wired and ready to operate. Maintenance is reduced because cabinet keeps equipment clean and out of harm's way. All three of the basic components — m-g set, control and drive motors — are designed to operate as a unit.

Engineering Assistance

Allis-Chalmers application engineers are thoroughly familiar with OEM problems and will be glad to help you at every stage of your operation. For help, call your nearby Allis-Chalmers District Office. For literature, write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B8166. A-4620

Vari-Pitch is an Allis-Chalmers trademark

Other Allis-Chalmers Speed Control Drives

Mechanical

Where a moderate speed range is required and where the machine may be stopped to make required speed changes. Horsepower range — 1½ to 300. Speed adjustment range — 9 to 28 percent. Two *Vari-Pitch* sheaves used together double range of adjustment.

Mechanical

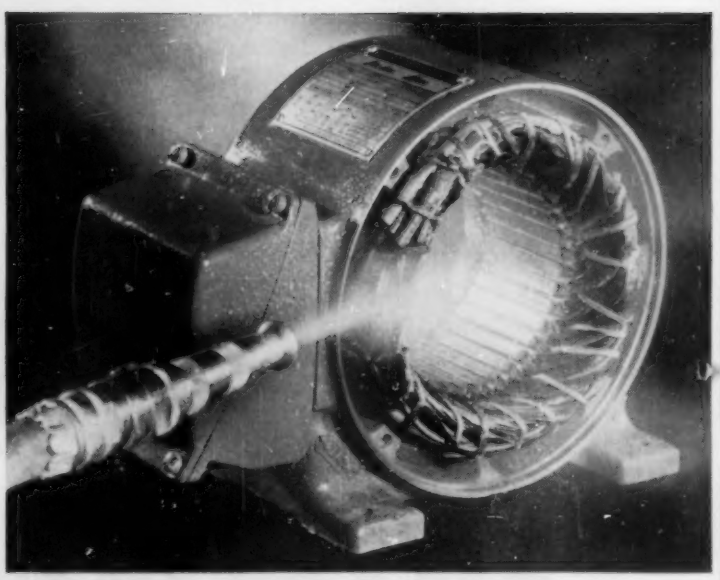
Where speed must be changed while machine is in motion. Particularly good for machines requiring fine adjustment while operating. Double range of adjustment may be obtained by using two *Vari-Pitch* sheaves. Horsepower range—1½ to 600. Speed adjustment range —9 to 28 percent with one *Vari-Pitch* sheave.

Electrical

Where stepped speed control is satisfactory. Available with stepless control in larger sizes by using liquid rheostat. Speed is varied by means of control on secondary windings of motor. Horsepower range — 5 hp and up. Speed adjustment range — 30 to 96 percent of synchronous speed for fan duty.

CHALMERS

MOTOR FACTS ON INDUSTRY'S
MOST PREFERRED "POWER PACKAGE."



Electrical System Fact—New exclusive Bondite impregnating varnish, partner to new Bondar and Mylar* insulations, guarantees complete resistance to weather. It doesn't just repel, it resists—all the way through.

*Du Pont Registered Trade-Mark

FACT:

The new Life-Line A is the most weather-resistant motor on the market

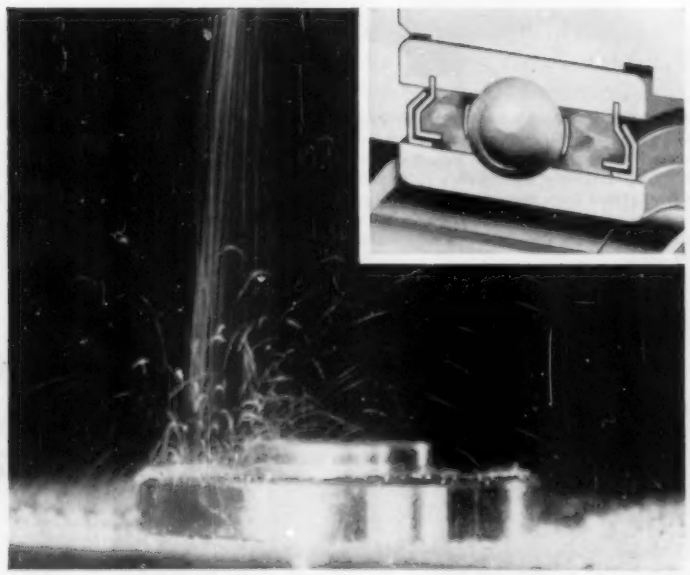
Whether your application is hot—cold—wet or dry, you'll find the new Westinghouse Life-Line® "A" motor will last longer under more extreme weather conditions than any other motor you can buy.

New insulation materials, housing designs, 4-way sealed bearings are tangible evidence of electrical, mechanical and lubrication system improvements that make Life-Line "A" industry's most preferred package of power.

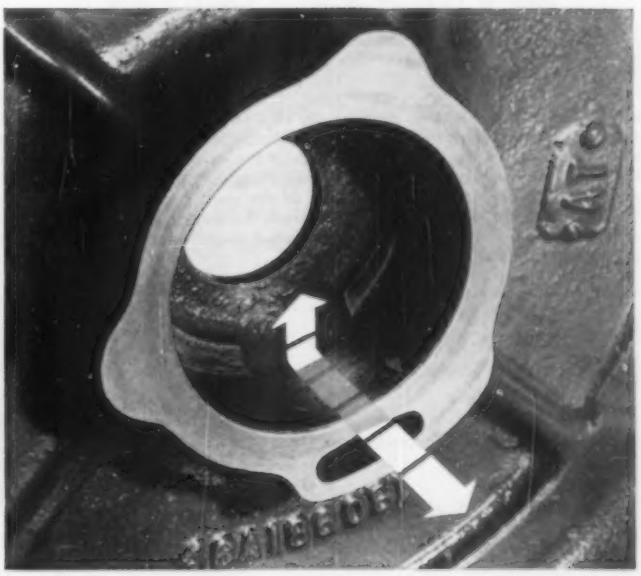
Get all the facts by calling your Westinghouse sales engineer . . .
The Man With The Facts.

J-21882

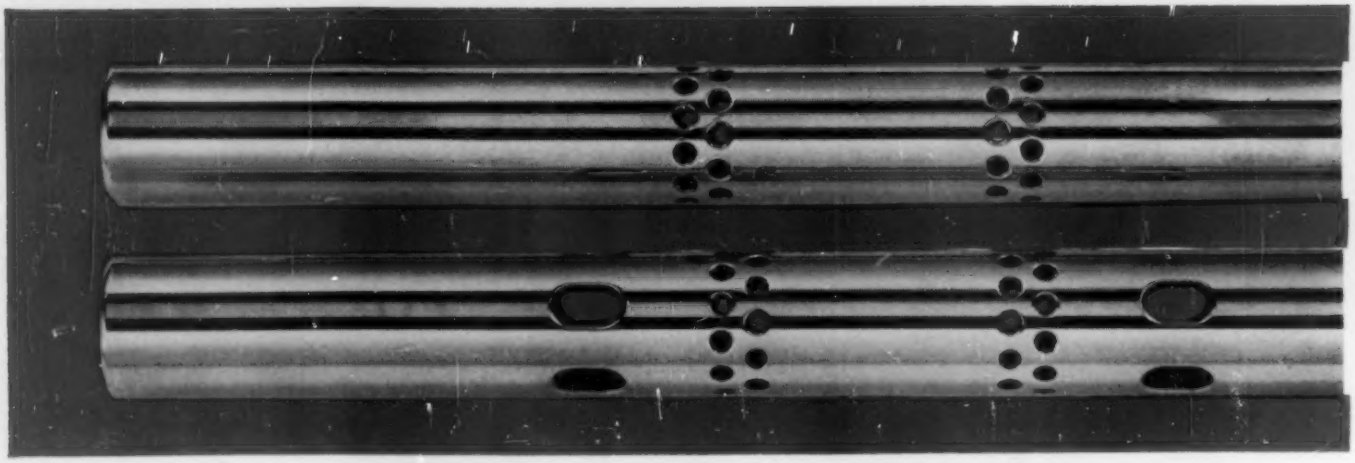
YOU CAN BE SURE...IF IT'S Westinghouse



Lubrication System Fact—Two outer seals of new 4-way sealed bearing act as flingers and literally (see photo above) throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth with outer seals.

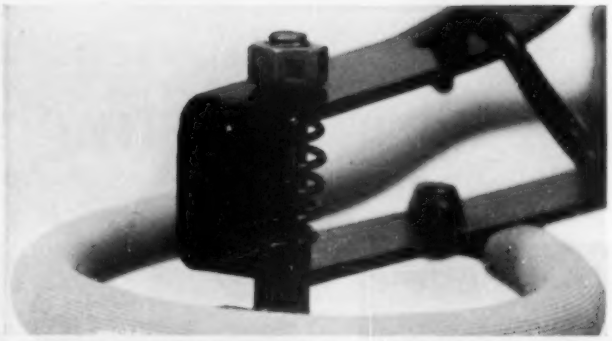


Mechanical System Fact—New exclusive air by-pass on totally-enclosed motor permits the motor to breathe around the bearing—not through it—minimizing atmospheric damage. Finest grained castings used in new cast-iron housings.



Free-machining ENDURO®

CONTROL MACHINING COSTS on mass-produced steel parts with Republic Hot Rolled Carbon Special Sections. These automobile door hinges were actually produced at less cost because much of the machining was eliminated. The special sections from which the component parts were made conformed to the predominating cross section of the part. Parts were cold formed by broaching. Tapping and drilling were the only other machining operations necessary. Republic supplies hot-rolled special sections in carbon, alloy and stainless steels.



CONTROL TENSION AND VIBRATION with Republic "Nylok" Nuts. They assure positive locking even under severe shock, vibration and tension. Here they are used to provide positive adjustment of spring compression. "Nylok" Nuts speed assembly, too. There's no fumbling to find the right side. Either end is up. Feed them automatically at full production speeds. Or manually for piecework. No special tools, lubricants or techniques are needed. They can be backed off for inspection and maintenance of parts and then can be re-used.

REPUBLIC STEEL CORPORATION
3150 East 45th Street,
Cleveland 27, Ohio

REPUBLIC STEEL

Please send more information on:

- ☐ Free-Machining ENDURO®
- ☐ Hot-Rolled Special Sections
- ☐ High-Strength Steels
- ☐ Republic "Nylok" Nuts

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Company_____

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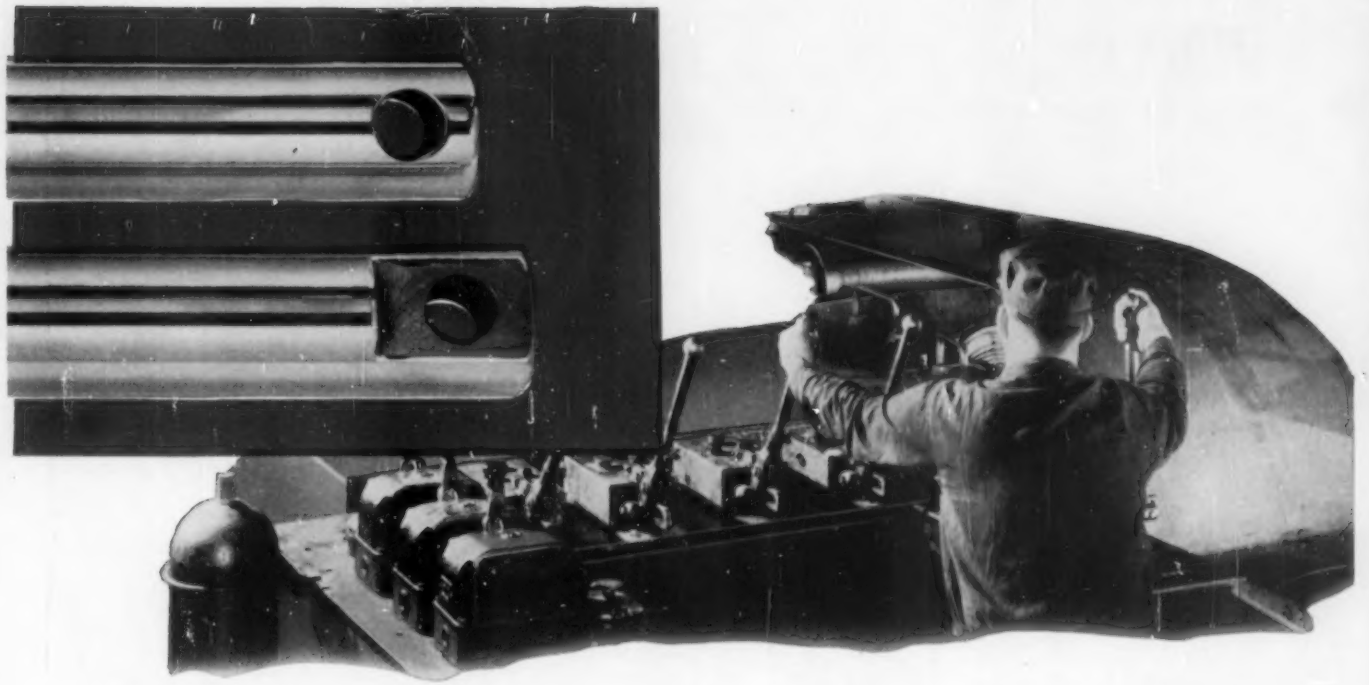
K-8124A

CONTROL EXCESS WEIGHT with Republic High-Strength Steels. When mobile equipment like earth movers, railroad cars, truck and gasoline trailers are designed and engineered from the beginning to take full advantage of the high strength and low weight of Republic High-Strength Steel, you can cut weight up to 50%. Corrosion-resistant qualities mean longer life for equipment, too. Republic High-Strength Steels are available in a wide range of sizes of sheets, plates and bars to meet your requirements.



helps control costs on highly machined stainless parts

These stainless steel plungers for pneumatic and hydraulic control valves require 30 separate machining operations in producing them. Costs could be expensive. But the manufacturer controls them by using Free-Machining ENDURO Stainless Steel Bars.

Republic's Union Drawn Division produces cold drawn bars with a fine surface finish, close tolerance, accuracy of section, uniform soundness for fast, economical production on highly machined parts like these. Free-Machining ENDURO provides the added strength and corrosion-resistance of stainless steel. Two grades, A.I.S.I. 416 and 430-F, are fully 90% as machinable as Bessemer Screw Stock.

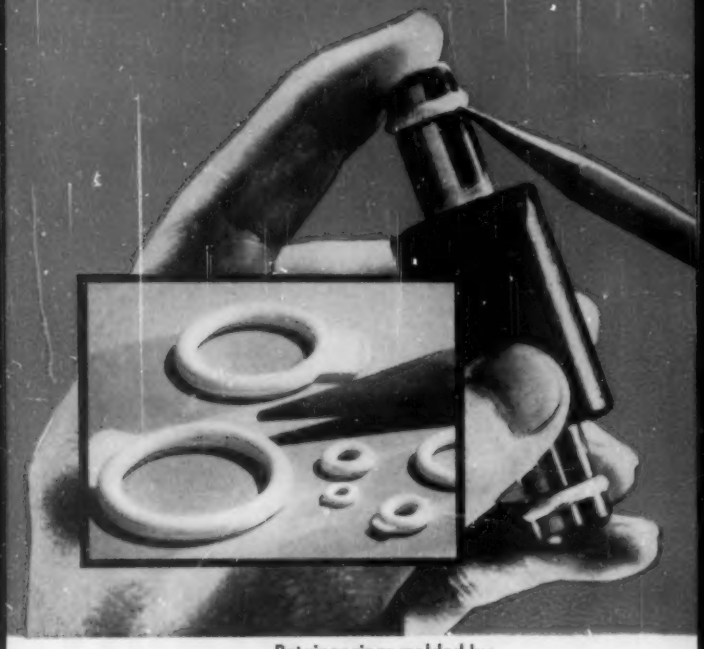
Thus, you can apply the high physical properties and corrosion resistance of stainless steel to your duplicate steel parts—and still maintain economical, automatic production—by switching to Free-Machining ENDURO.

Republic ENDURO Stainless Steel is available in all forms, including hot rolled bars, special sections and wire. Republic metallurgists and engineers will give you expert assistance on applications, processing and use. Specify ENDURO on your next order for stainless steel bars. Mail the coupon for more information.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

BAKELITE
VINYL
PLASTICS



Retainer rings molded by
Shakeproof Division, Illinois Tool Works, Chicago 39, Ill.

These retainer rings call for a tough material. They fit into grooves on the ends of revolving shafts and keep wheels and bearings from slipping off. That's why they're molded from BAKELITE Brand Vinyl Plastic.

Their elasticity makes them easy to install or remove, gives them a tight grip in the groove. Air hammer vibration tests and cycle tests on solenoid arms, performed by the manufacturer, prove that they withstand 10,000,000 operations—100 times better than a cotter pin, 10-20 times better than a metal snap-ring.

BAKELITE Vinyl Plastics are resistant to oils, grease, water, and most chemicals. They offer great fidelity of mold detail, even for tiny pieces like these.

BAKELITE
PHENOLIC
PLASTICS

Handle for the "Sunbeam" Automatic Fry Pan molded by
Chicago Molded Products Corp., Chicago 51, Ill.

The handle for this automatic fry pan also houses the control element, so it requires a material that combines good appearance with superior molding qualities.

BAKELITE Brand Phenolic BMG-5000 Black 25 meets all the requirements. The big, comfortable handle has a rich black color and gleaming finish. It's molded with precise inner details to fit the delicate control mechanism. The stainless steel tubes are molded in for a watertight seal; the pan can be safely immersed in water up to the control element.

Durability and heat insulation were also important considerations in the selection of BMG-5000 Black 25. The handle is as functional as it is handsome.

BAKELITE

TRADE-MARK

GREATEST VARIETY, LARGEST RESOURCES FOR PLASTICS KEYED TO YOUR NEEDS

The success of a plastic product is based on selection of the right material. Bakelite Company helps you meet this problem in several ways. Here is a single source of supply for plastics and resins that have widest application. Plants and warehouses are strategically located for prompt delivery and service. And you can call on Bakelite Company technical representatives for guidance. They are backed by extensive research and development facilities and by Bakelite Company's 45 years of experience in the plastics industry. Write Dept. GS-145.

BAKELITE
STYRENE
PLASTICS

"Linex" Stereo Viewer made by
Linex Division of the Lionel Corp., Irvington, N. J.

A stereo viewer takes a lot of handling when slides are changed and it's passed around. Sometimes it's taken apart to change bulbs or batteries. In addition, it has to have a quality appearance.

That's why this one is molded from BAKELITE Brand High-Impact Styrene TMD-5151. This material is tough, dimensionally stable, and resistant to warping and shrinking. Sections form a clean, tight fit. The viewer also has a soft matte finish that always looks attractive.

The high plasticity of TMD-5151 results in the fastest set-up speed available in a high-impact styrene —another reason why it's so popular with molders.

BAKELITE
POLYETHYLENE
PLASTICS

"Nomus" paint can top molded by
Rainbow Plastic Products Co., Minneapolis 16, Minn.

Molding this paint can collar of BAKELITE Brand Polyethylene provides several practical benefits. Inherent flexibility makes it easy to attach or remove. Accurate molding assures a tight fit. Paint won't harm it.

Molded for either quart or gallon sizes, the collar seals the can edge, keeps paint from running down sides or getting into the lid groove. It even has a brush-wipe molded in—another plus for neatness.

BAKELITE Polyethylene, the lightest commercial plastic, is excellent for many jobs requiring toughness and high mechanical strength, even with unusual shapes. It can also be given a wide range of colors and has outstanding dielectric properites.

BAKELITE
BRAND
PLASTICS

PHENOLICS · STYRENES · IMPACT STYRENES
POLYETHYLENES · VINYLS · POLYESTERS
EPOXIES

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

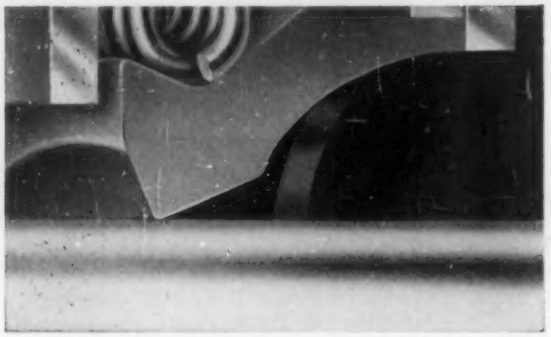
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Be sure of

LOW LOW LOW

with NATIONAL

Exclusive Syntech sealing lip cuts torque in half.



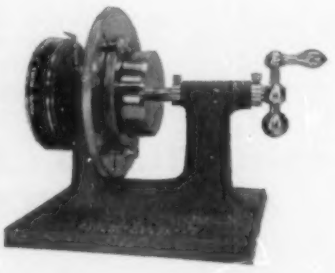
National Syntech® synthetic rubber seals are engineered for higher speeds and temperatures; applications where torque must be held to the absolute minimum. Syntech seals have unique sealing lip design to provide minimum contact between lip and shaft. This design reduces torque up to 50% over conventional sealing lips. Operation is cooler; service life is longer, and there is no measurable leakage. National Syntech seals are available with rubber covered or ground metal O. D.'s, and are unaffected by most industrial fluids.

National Micro-Torc oil seals employ a sealing lip of leather, surface coated with a high lubricity elastomer. The exceptional lubricity of

Shaft Size	Break Away Torque		Running Torque	
	Conventional Leather	Micro-Torc	Conventional Leather	Micro-Torc
1.500"	39 oz-in	7 oz-in	60 oz-in	36 oz-in
2.937"	126	39	253	164
3.812"	95	49	287	207

Micro-Torc's surface coating permits cooler running, "inside" oil storage, lower torque.

New, portable meters measure oil seal torque to 60 in. lbs.



OIL SEALS

this coating helps reduce torque as much as 80%, yet permits operation with no measurable leakage. Because the coating is surface only, the body of the sealing lip retains its inherent porosity to store oil for periods of semi-starved operation. Operation of Micro-Torc is cooler, and service life is materially longer.

National Torque Meters fill industry's need for a quick, accurate way to measure oil seal torque in standards determination, quality control and parts inspection. They provide laboratory accuracy, yet are rugged, fool-proof, easily used by anyone. Two models are offered: one measuring torque to 15 lb. in. on seals to 6" diameter and one measuring torque to 60 lb. in. on seals to 8" diameter.

Factory trained field engineers at your service

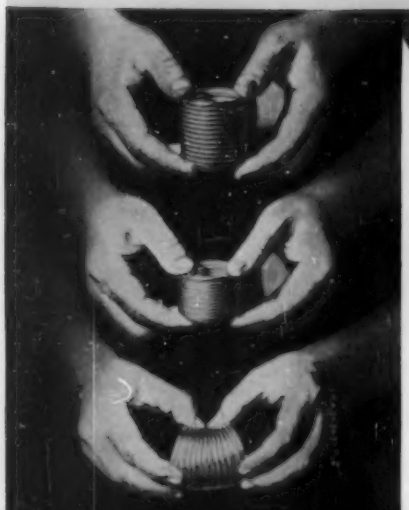
CHICAGO, ILL. . . . *Room 4113 Field Building, FRanklin 2-2847*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
INDIANAPOLIS, INDIANA . *2802 North Delaware St., WAlnut 3-1535*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif., Downey (Los Angeles County), Calif., Van Wert, Ohio

FULTON SYLPHON

BELLOWS HEADQUARTERS,



Seamless Metal Bellows

The Sylphon Bellows was originated by Fulton Sylphon over 50 years ago. Its unique one-piece expansible and collapsible design is used widely for diaphragm effects, flexible connections and expansion chambers.

All Types, Sizes and Metals

Fulton Sylphon Bellows are all designed to specific customer requirements. They are furnished in a limitless number of sizes, a complete range of types and metals and with many different reaction characteristics.

On-Call Engineering Service

Fulton Sylphon Bellows Engineers are strategically located in all industrial areas of the country. This "near-by" service is on-call to help you determine the right bellows metal, correct bellows charge and most economical design for your specific application.

U.S.A.

For the conversion of pressure effects into controlled movement, the operation of valves and switches in response to temperature change, the absorption of thermal or pressure expansion or the absorption of vibration—a seamless metal bellows may be your best design solution. The best way to find out, is to consult a Fulton Sylphon engineer. He'll focus more than 50 years experience in bellows engineering on your problem.

Mr. Controls

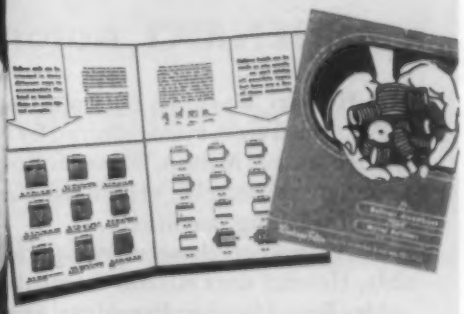
Robertshaw-Fulton
CONTROLS COMPANY
FULTON SYLPHON DIVISION

Assemblies and Complete Devices

By purchasing complete bellows assemblies and devices rather than buying bellows units, many manufacturers achieve significant production economies. Fulton Sylphon is singularly equipped to design and produce complete assemblies at low cost.

On-Time Delivery • No Delays

Fulton Sylphon's mass production facilities are geared to good service. Exceptional quality control techniques often eliminate any need for customer's in-coming inspection. Customer service and shipping follow-through assure on-time delivery without costly delays.



BASIC BELLOWS ENGINEERING and ways Fulton Sylphon can serve you are described in this 32 page Bellows Catalog. It makes profitable reading . . . use the handy coupon to get your free copy.

FULTON SYLPHON DIVISION
Knoxville 1, Tennessee

☐ Please have a Bellows Engineer call me for an appointment.

☐ Send me Bellows Catalog No. RP-1400

Name_____

Company_____

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Give Dependable, Accurate Performance in HENRICI Automatic Washing Machine Controls

The Henrici Washing Formula Control Model HT-2, illustrated, manufactured by Fritz Henrici, Incorporated, Milton, Mass., follows a formula program accurately, providing automatic control of washing machinery.

To help keep these units operating dependably, Henrici uses Klixon Controls.

Mr. Fritz Henrici, President, states —

> "We have been using Klixon Controls in the Henrici Automatic Formula Controls for over 10 years. We have absolute confidence in Klixon Controls by observing their reliable performance in thousands of applications."

What's your control problem . . . low or high temperature limitation, fuel delay, tube and rectifier cooling, fan or burner operation . . . Klixon Thermo-Snap Controls are successfully meeting the requirements of a variety of such applications in military and civilian equipment, daily.

Klixon Thermo-Snap Controls are available in a number of hermetically sealed and open construction types with fixed temperature settings to meet your needs.

Klixon Engineers, specialists in temperature control applications, will gladly help you work out application details. Why not write in, outlining your application? You'll be under no obligation . . . and it may turn out to be greatly to your advantage.

Typical Klixon Thermo-Snap Controls that have helped solve many temperature control problems.

KLIXON

TRADE MARK REG. U. S. PAT. OFF.

METALS AND CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
909 FOREST STREET, ATTLEBORO, MASS.

Use **GENERAL PLATE** Composite Contacts to cut costs,

Brighten Your Product's Future

increase production, and provide reliable performance

General Plate's "know how" in the production of Composite Contact Materials can indeed brighten your products' future. By having General Plate fabricate your complete contact assemblies, you will save money, time, and trouble . . . eliminate needless equipment cost and problems of scrap disposal . . . and have at your disposal contacts and contact assemblies made to exact specifications shipped to you ready for installation when you want them.

Or, you may prefer to fabricate your own assemblies. General Plate Composite Contact Materials — available in overlay, edgelay, top-lay and inlay strips — make it possible for you to produce complete contact assemblies to close tolerances by simple blanking and forming operations.

In either case, comparison of the final costs of properly designed Composite Contact Assemblies fabricated from General Plate Composite Contact Materials against costs of similar assemblies produced by older methods of brazing, welding, staking, or spinning will reveal the resultant economies and fabricating ease available to you.

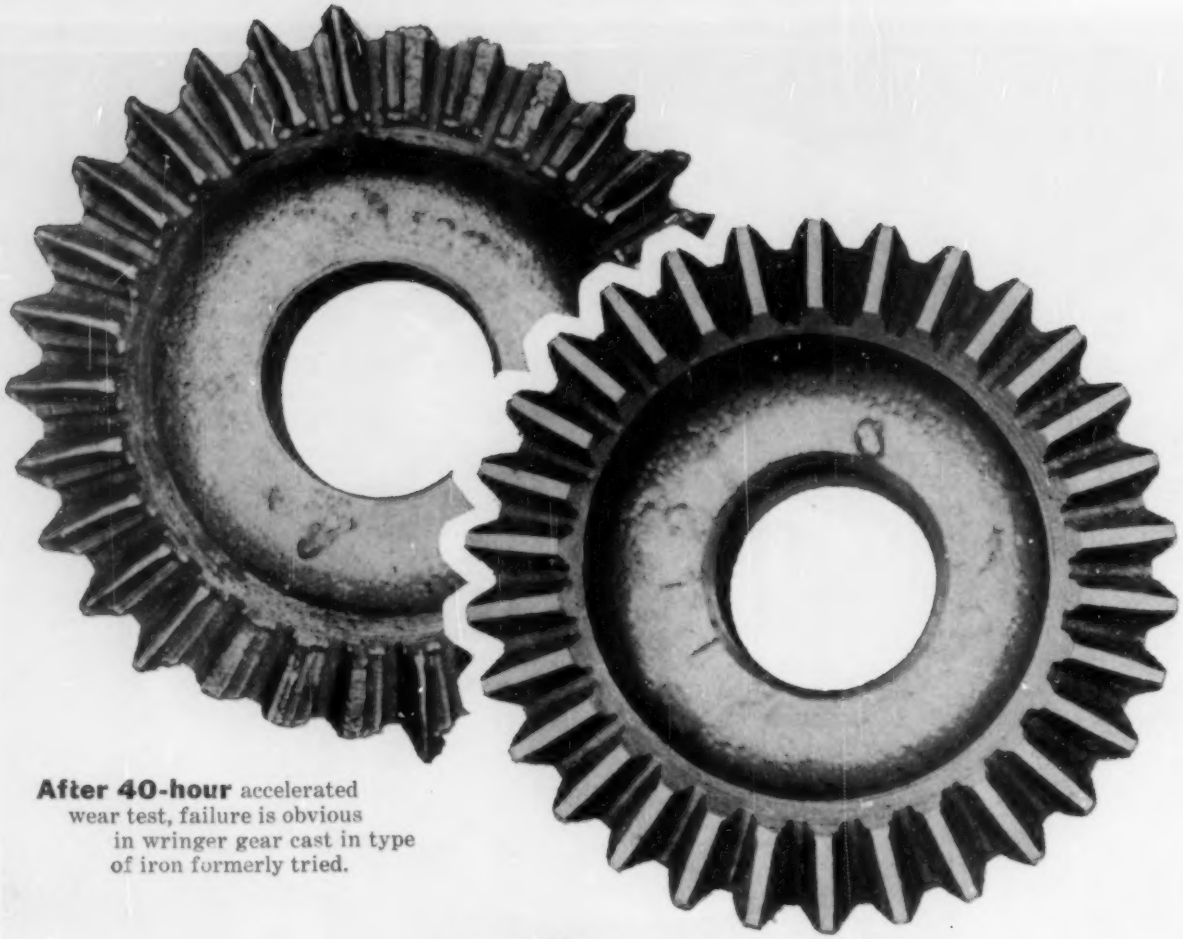
Write for complete information and catalog PR700 which describes General Plate Composite Contacts and other General Plate Composite Metals.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
19 FOREST STREET, ATTLEBORO, MASS.

GENERAL PLATE ELECTRICAL CONTACT KITS FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are composite metal strips for fabrication of contact posts. These kits are available at nominal cost.

You can profit by using General Plate Composite Metals!



After 40-hour accelerated wear test, failure is obvious in wringer gear cast in type of iron formerly tried.

After 256 hours of identical testing, this Ductile Cast Iron gear shows distinctly superior resistance to wear.

Over 500,000 gears prove you can minimize rejects with Ductile Cast Iron

USERS AND PRODUCERS ALIKE gain basic advantages from Ductile Cast Iron.

Here's a typical example, a wringer gear cast in Ductile Iron for washing machines made by The Maytag Company of Newton, Iowa. More than 500,000 such gears now in service attest to two facts: satisfactory response to fabrication, and satisfactory performance for users.

Wringer gears must defeat wear to extend gear life. Test and performance records show how fully Ductile Iron gears meet this need.

But despite high wear-resistance, Ductile Iron is machinable. Indications of improved tool life and finish add to the fabricator's satisfaction with this versatile iron.

In the foundry . . . rejections have been almost zero.

"Castability" of Ductile Iron spells volume output in St. Paul Foundry & Manufacturing Company, St. Paul, Minn., and in Jamestown Malleable Iron Company, Jamestown, N. Y., producers of wringer gear castings for Maytag home washing machines.

Try Ductile Cast Iron. Learn first-hand, how it outperforms other materials under tests and in service. Write now for a copy of the new booklet entitled, "DUCTILE IRON, THE CAST IRON THAT CAN BE BENT."

It's yours for the asking. We'll also send you the latest list of authorized foundries now producing Ductile Cast Iron under patent licenses. Write to INCO now.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

DU PONT
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Better Things for Better Living . . . through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 6 — 1955

How 3 Du Pont engineering materials helped solve a design problem...produce a better product

Du Pont engineering materials improve design! The "Magna Impella" on this drink dispenser uses three Du Pont engineering materials: "Alathon" polyethylene resin, "Teflon" tetrafluoroethylene resin, and "Lucite" acrylic resin.

Improved design eliminates stuffing box and mechanical linkage

THIS "Jet Spray Cooler" pictured at left has an interesting operating story—centered around the use of three Du Pont engineering materials. Unlike the usual drink dispenser, which needs a linkage to the motor to spray liquids inside the bowl, this dispenser circulates liquid by *magnetic action*.

Here's how it works

A permanent magnet is imbedded in an impeller of Du Pont "Alathon" that sits in a well on the bottom of the bowl. "Alathon" polyethylene resin is used because it's tough, absorbs very little moisture, can be molded around inserts, and resists corrosion. Directly below the impeller is a powerful, motor-driven horseshoe magnet. The motor turns the horseshoe magnet, which in turn spins the impeller. Liquids are forced up through a connecting tube of opaque Du Pont "Lucite" acrylic resin and out into the bowl.

Needs no oiling

The impeller shaft revolves on a bearing of Du Pont "Teflon" tetrafluoroethylene resin. This material has toughness combined with an extremely low coefficient of friction. It needs no oiling—eliminates any possibility of contamination. And topping the drink dispenser is a sparkling bowl of injection-molded "Lucite"—outstanding for its transparency and resistance to discoloration.

Here, then, is another example of how products and processes can be improved through an imaginative use of these Du Pont engineering materials. Can they help your operation? Use the coupon on the back of this page for further information. (Dispenser manufactured by Jet Spray Cooler, Inc., Boston, Massachusetts.)

OVER

Specular glare eliminated with diffusers of extruded Du Pont LUCITE® acrylic resin

WORKERS perform tasks with greatest accuracy, speed and comfort under well-designed lighting conditions. Lighting engineers have established that a brightness ratio of 9 at light source to 3 at task area and 1 at surround is the most comfortable lighting environment.

Diffusers of Du Pont "Lucite" acrylic resin effectively assist in achieving this ideal ratio. Extruded sheets and panels of this durable engineering material transmit optimum light while eliminating glare and minimizing shadows. The rated lumen output of properly maintained fixtures of translucent white "Lucite" remains essentially constant through years of service, while resisting discoloration and other aging characteristics.

Write for information on lightweight, shatter-resistant "Lucite".

DU PONT
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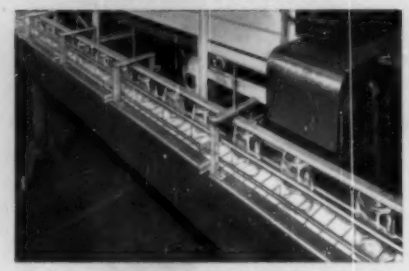
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

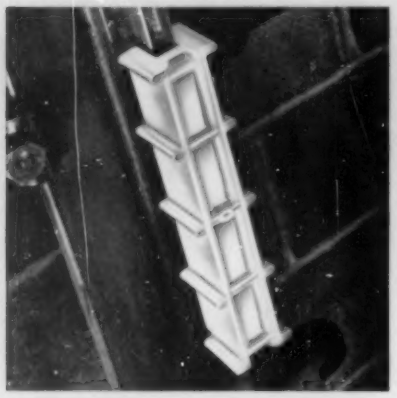
NO. 6 — 1955

Properties of ZYTEL® nylon resin demonstrated with these new product applications

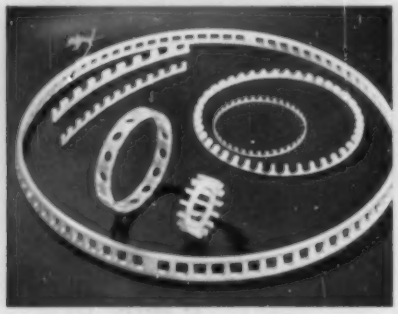
THESE typical applications of Du Pont "Zytel" nylon resin illustrate some of the properties which make this versatile material so useful to the design engineer. The properties of "Zytel", used singly or in combination, provide the opportunity to evaluate product improvement or new product development in terms of this Du Pont engineering material.



(1) Parts of "Zytel" resist abrasion Used for guide shoes which connect elevator cars to vertical guide rails and slide along the rails at speeds up to 1000 feet a minute, "Zytel" nylon resin exhibits remarkable abrasion resistance. "Zytel" gives much longer service than materials previously used, yet requires no lubrication. Guide shoe molded by Paragon Molding, Inc., Melrose Park, Illinois, for the Adams Manufacturing Company, Chicago, Illinois.



(2) Parts of "Zytel" often need no lubrication New conveyor chains made from links molded of "Zytel" nylon resin assure long service life and low maintenance costs. These chains of "Zytel" run smoothly without lubrication, saving the cost of lubricants. Power costs are cut, too. Tests show that the belts of "Zytel" carry, with 1/5 to 1/2 the chain pull, a load carried by comparable lubricated steel chains. Links molded by Du Bois Plastic Products, Inc., Buffalo, N. Y., for Fenco Inc., Chicago, Illinois.



(3) "Zytel" can be molded into intricate parts Design engineers specify "Zytel" nylon resin for a great variety of product designs where its ability to be molded into intricate shapes proves desirable. Single parts of "Zytel" often replace multi-part assemblies of other materials. The moldability of "Zytel" nylon resin is well illustrated by the seven samples of molded bearing cages shown above. Cages manufactured by the Kaydon Engineering Company, Muskegon, Mich.

(4) Parts of "Zytel" are tough Heat-treated metal facings were used on a continuous-operation clutch. The clutch revolves at 1750 R.P.M., transmits 75 ounce-inches of torque, undergoes up to 1440 engage-disengage cycles a day. The metal facings had to be replaced 17 times a year. Facings of tough, molded "Zytel" were installed. Replacement has been cut to 3 times a year. Clutch molded by the Danielson Manufacturing Company, Danielson, Conn., for Minnesota Mining and Manufacturing Company, St. Paul, Minn.

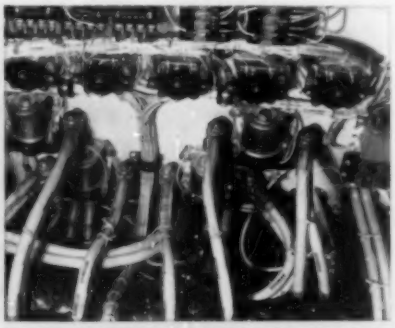
(5) High-temperature applications utilize "Zytel" This silverware basket molded of "Zytel" nylon resin, used in the 1955 General Electric dishwasher, withstands scalding temperatures without cracking or distortion. Baskets of "Zytel" can be handled promptly after leaving the dishwasher. These resilient baskets of Du Pont "Zytel" nylon resin will not break or dent if dropped. Basket molded by Plastics Division, General Electric Company, Decatur, Illinois.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.



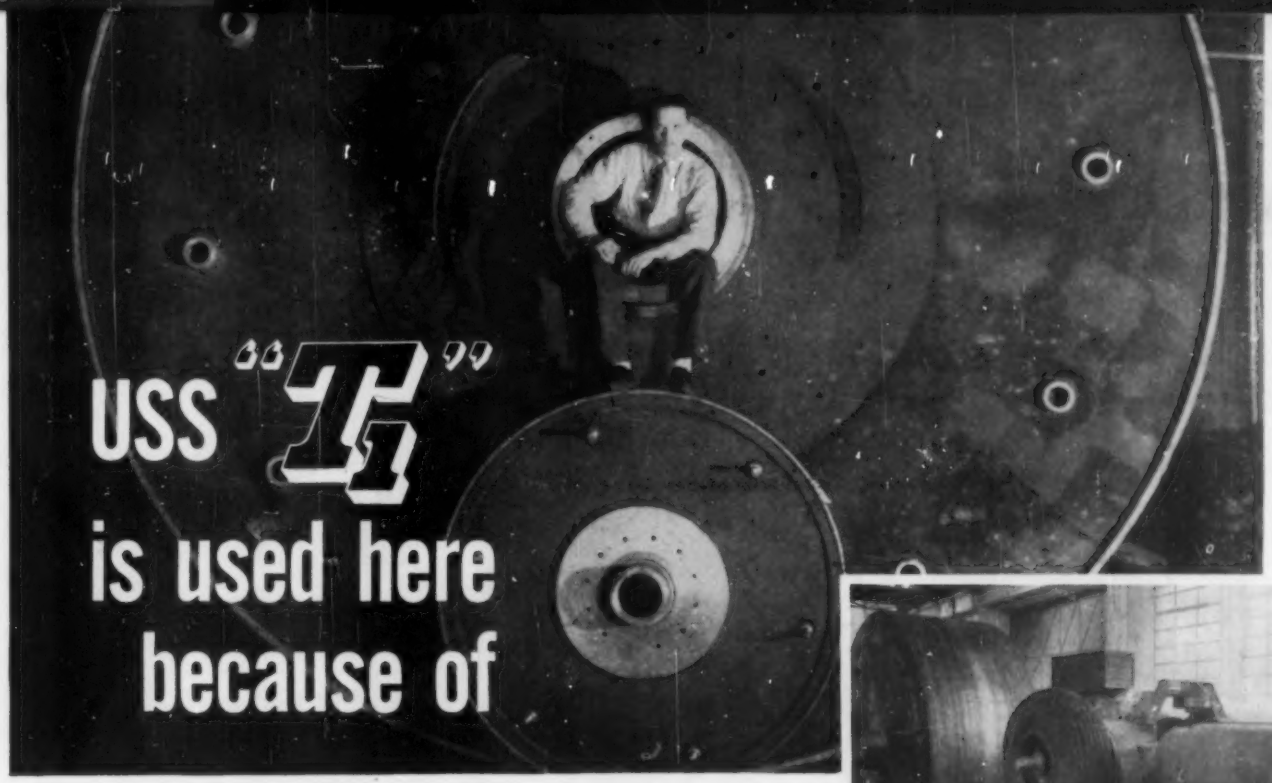
(6) "Zytel" resists heat "Zytel" nylon resin is useful for many applications where heat resistance is important. Because of its ability to withstand use at temperatures up to 250°F., together with its toughness and resistance to abrasion, "Zytel" is used for aircraft cable clamps, strain-relief clamp blocks, grommets, wire guides and support blocks, terminal blocks, and like parts. "Zytel" nylon resin is useful, too, as cable jacketing, because of its resistance to heat and gasoline.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 109, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for:

NAME _____ POSITION _____
COMPANY _____
STREET _____
CITY _____ STATE _____
TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon", and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)



USS "T1" is used here because of

'ROUND AND 'ROUND the flywheel goes, at a speed of 300 mph. Suddenly, an aircraft wheel assembly rams against it, with the impact of a loaded airplane. The tire squeals, the brake is applied, and in just 20 seconds the wheel stops. A real rugged test—both for the wheel assembly and for the steel in the flywheel. USS "T-1" Steel passed the test. In fact it is the best steel that could be used for this high speed application.

...its great strength

...its ease of fabrication

High speed tire, brake, and wheel testing machines like the one shown here, manufactured by Adamson United Company, Akron, Ohio, a subsidiary of United Engineering and Foundry Co., are used to prove out aircraft landing gear. The gigantic flywheels on these machines simulate the speed and inertia of an actual airplane during landing and take-off.

Until a short time ago, testing machines were built to rotate at peripheral speeds up to 250 mph. But when the aircraft industry spread its wings, faster testing machines were needed. The new machines had to rotate at speeds as high as 300 mph—and stay in one piece. They had to be extremely strong . . . lightweight . . . and easy to fabricate.

That's when USS "T-1" Steel entered the picture.

For flywheels rotating 300 mph, a steel of extremely high tensile strength was needed to withstand the tremendous stresses generated. A steel permitting the greatest strength for the thinnest section was needed. And, above all, the steel had to be capable of developing full 100% weld strength.

USS "T-1" Steel more than met all Adamson United's requirements.

Other steels could have provided the strength and met the weight requirements. None but "T-1" provided these and good weldability too.

UNIQUE PROPERTIES—"T-1" Steel's unique combination of physical properties has solved many similar problems. "T-1" can be welded satisfactorily *without* pre- or post-heating —it can be welded either in the shop or field. Always, it provides great tensile strength (105,000 psi minimum with yield strength of 90,000 psi minimum), phenomenal toughness and excellent abrasion resistance. Write for full particulars. United States Steel, Room 4907, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

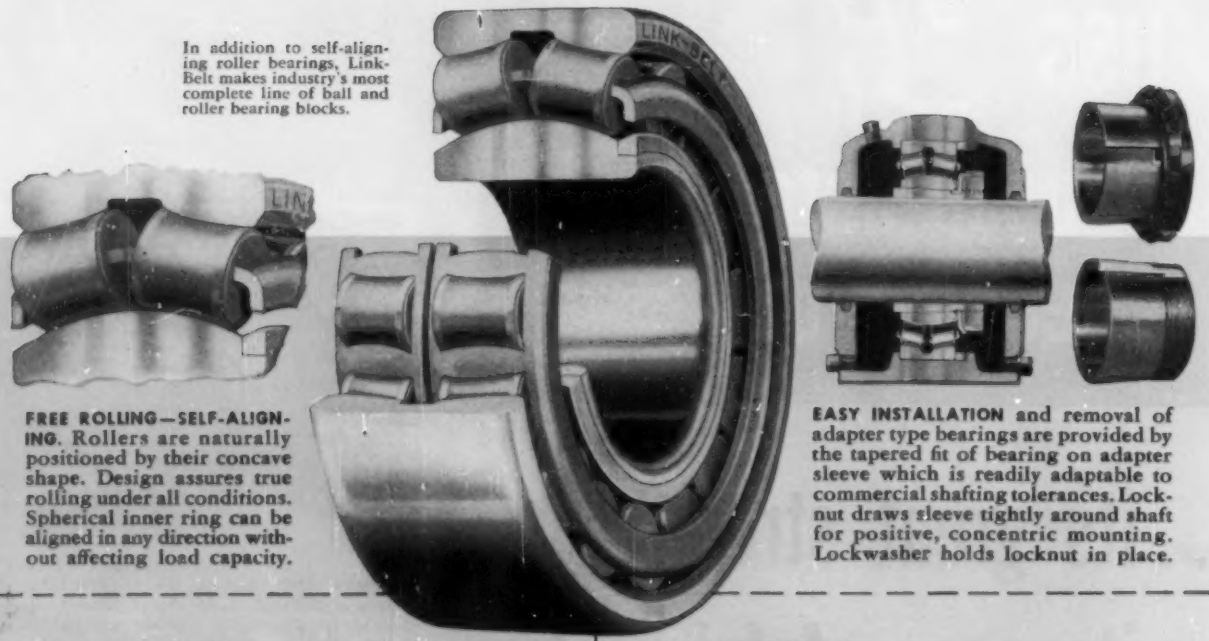
USS "T1" CONSTRUCTIONAL ALLOY STEEL

UNITED STATES STEEL

For tough, heavy-duty applications... Make use of these important

bearing differences

In addition to self-aligning roller bearings, Link-Belt makes industry's most complete line of ball and roller bearing blocks.

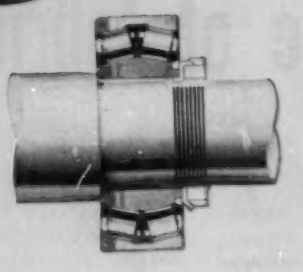


FREE ROLLING—SELF-ALIGNING. Rollers are naturally positioned by their concave shape. Design assures true rolling under all conditions. Spherical inner ring can be aligned in any direction without affecting load capacity.

EASY INSTALLATION and removal of adapter type bearings are provided by the tapered fit of bearing on adapter sleeve which is readily adaptable to commercial shafting tolerances. Locknut draws sleeve tightly around shaft for positive, concentric mounting. Lockwasher holds locknut in place.

LOCKED-IN CLEARANCE. Selective assembly of rollers and raceways with accurately formed hardened steel retainers assures proper operating clearance, guidance and spacing of rollers.

Rollers are completely pocketed in retainers for accurate spacing and guiding.



SMOOTH OPERATION, LONG LIFE are advantages of the straight bore type mounting, which assures maximum concentricity of inner ring with shaft. Especially desirable when minimum radial run-out is essential.

They're all present only in LINK-BELT self-aligning roller bearings

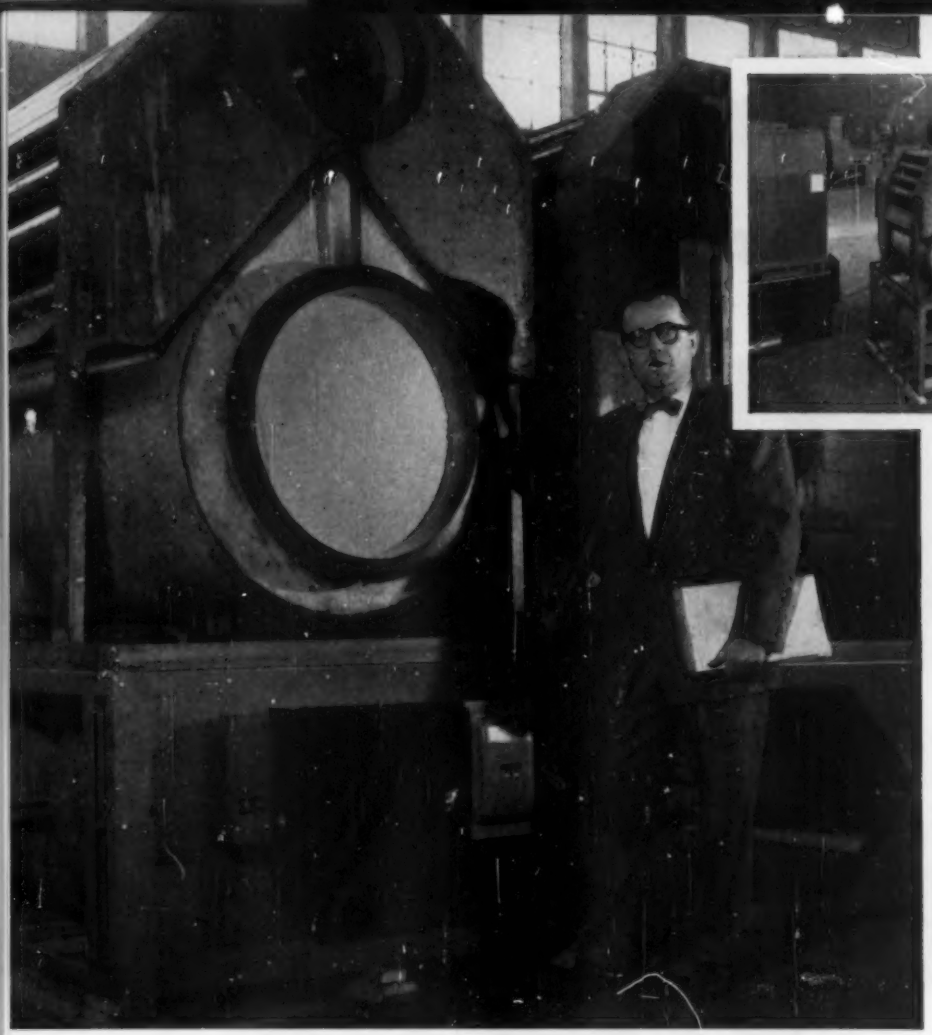
SUBTLE differences in bearings can make notable differences in the life and efficiency of your equipment. Take Link-Belt self-aligning roller bearings, for example. Their "self-contained" feature permits the bearing to float axially in the mounting, when desired, compensating for shaft expansion or settling of bearing supports . . . preventing extraneous thrust loads from being set up between bearings on the same shaft. What's more, inherent self-aligning design and preadjustment preclude use of expensive or cumbersome self-aligning housings.

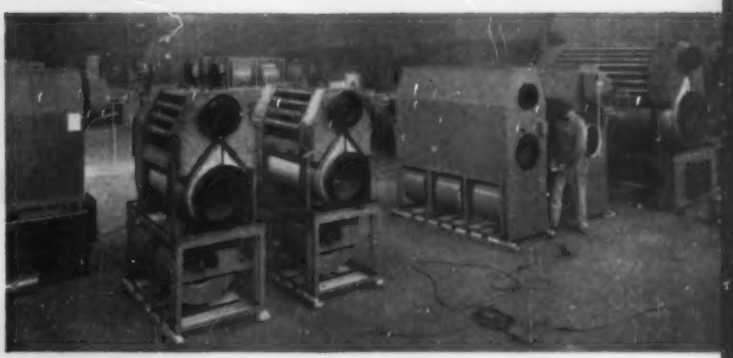
Ask your nearest Link-Belt office for Book 2196 on self-aligning roller bearings and Book 2550, containing full data on all Link-Belt ball and roller bearings.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,711





Final assembly of the heaters. Teardrop design of the firebox eliminates turbulence, permits entire surface to be wiped by air flow.

Mr. George Costello, Secretary-Treasurer, displays the Stainless Steel firebox for a National Heater.

Firebox is upside down for finish welding. Welders and other workers report no difficulty fabricating the Stainless Steel.

1945: Heater size reduced 25% with Stainless Steel

TODAY: *Increased unit efficiency—increased heater sales*

National Heater Company, St. Paul, Minn., has been making quality industrial heaters for 20 years. In 1945, they looked for a way to reduce the *size* of the units without reducing efficiency.

Primarily, it was a problem of moving the steel firebox walls closer to the flame. But carbon steel would eventually oxidize and lose its shape when brought too close to the flame. So they tried Stainless Steel, and it worked.

The new firebox was made from 14-gauge Stainless Steel. It retained its shape, strength and durability at the elevated temperature. It also eliminated the need for a refractory material.

The new firebox was 25% smaller than the old one. The Stainless Steel has given superb performance, and sales have increased.

There have been no fabricating problems. National Heater uses the same equipment for Stainless Steel that they use for carbon steel.

No other metal combines the corrosion resistance, strength, appearance and easy fabricating properties of Stainless Steel. Keep this remarkable metal in mind when you plan a new design – and for top quality, specify service-tested USS Stainless Steel.

See "THE UNITED STATES STEEL HOUR," Televised alternate weeks. Consult your newspaper for time and station.

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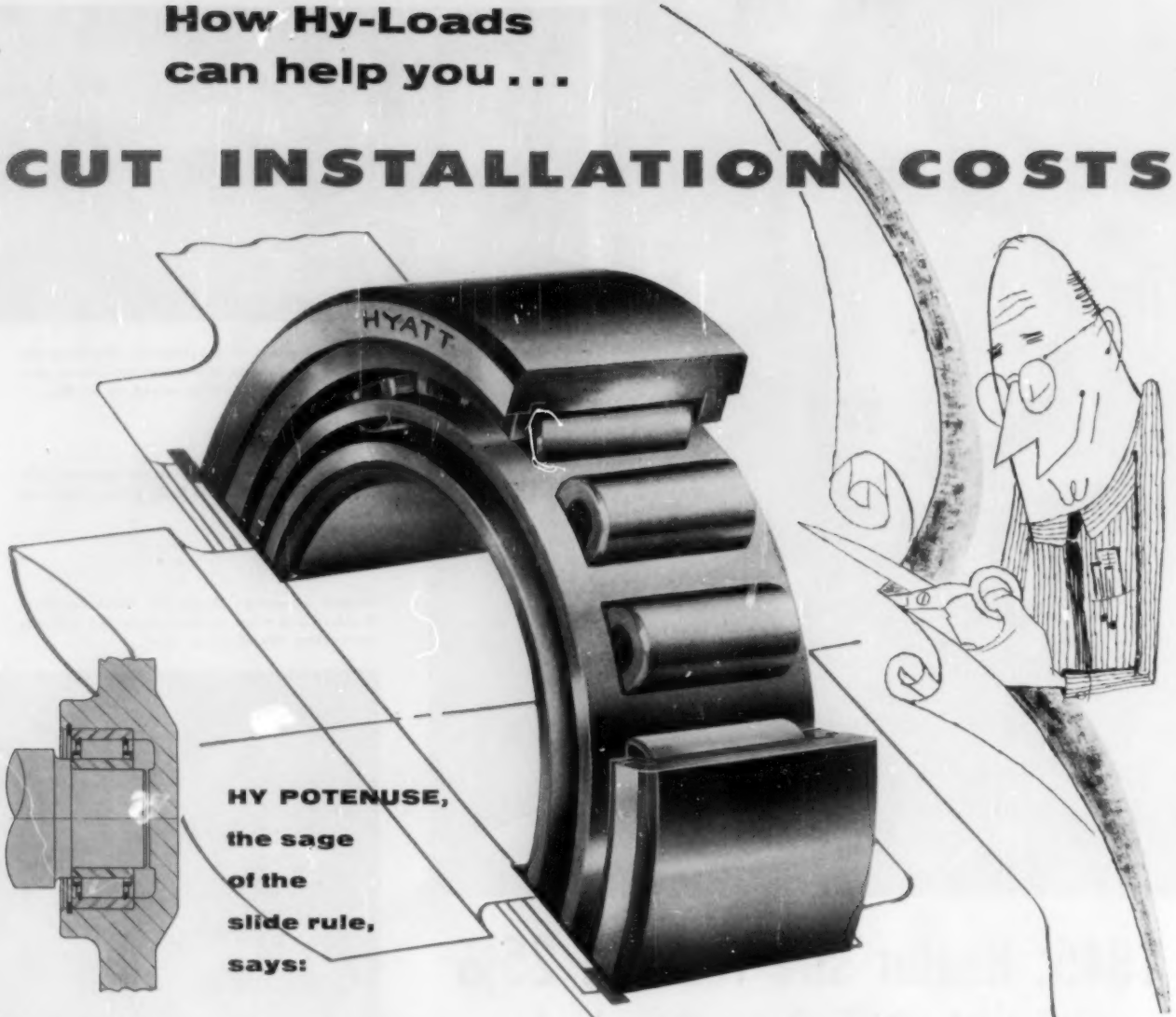
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

How Hy-Loads can help you . . .

CUT INSTALLATION COSTS



You don't need a lot of extra "holding gimmicks" with HYATTS!

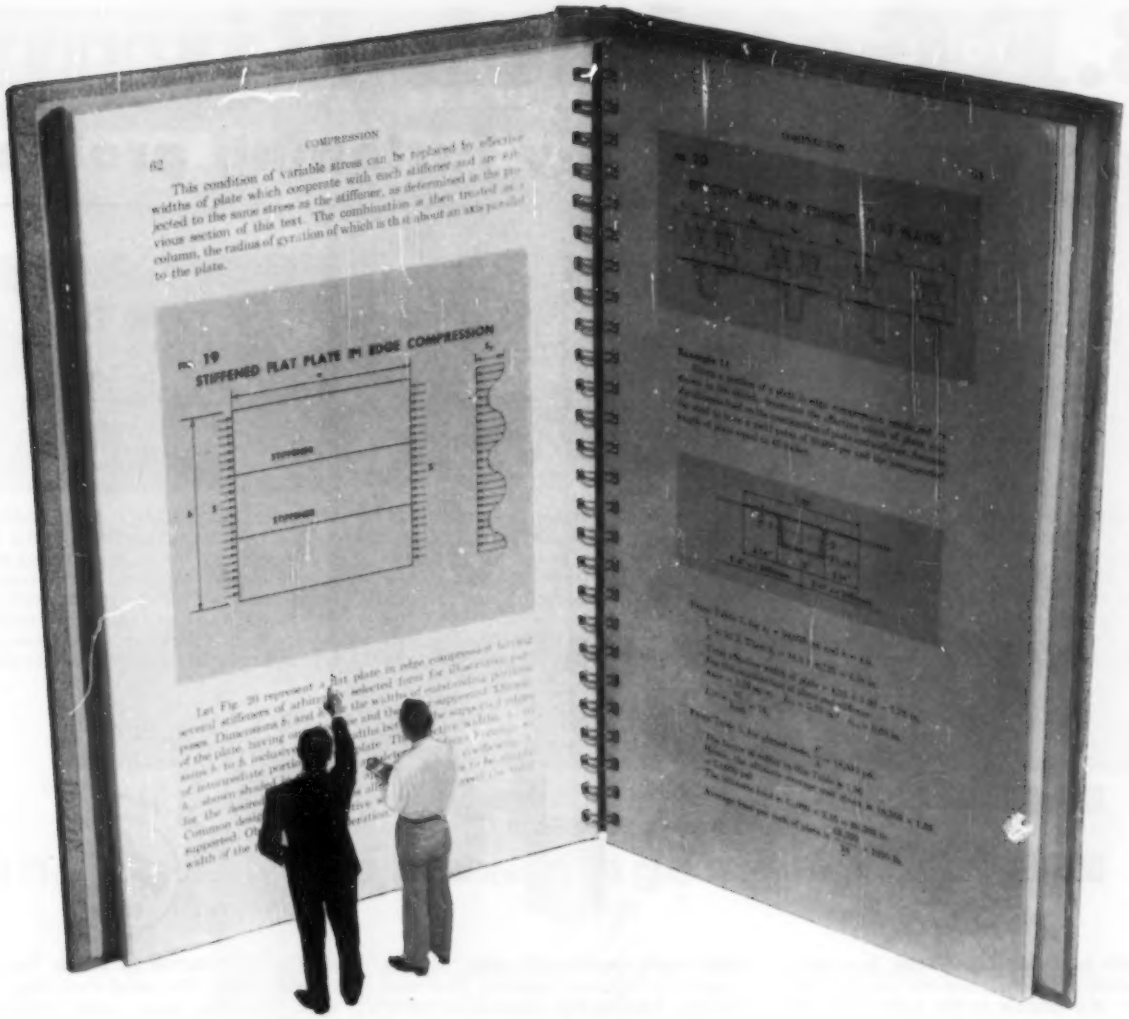
YOUR COMPLETE LINE OF CYLINDRICAL ROLLER BEARINGS

Look at this speed reducer, for instance. The inner race of the HYATT Hy-Load is held on the shaft with a heavy press or shrink fit—*nothing more!* No money wasted for end clamps, threads, nuts, screws or washers. And brother, that rotating HYATT race will *never crack or come loose* come h - - - or high water. Know why?

HYATT races are made from low carbon alloy steel which, after carburizing, provides a *ductile core* and *case hardened operating surfaces.* That's why they'll take press fits and shock loads that would be suicide for the through-hardened steel used by other bearing makers. Naturally, it costs HYATT more to maintain the industry's finest heat-treating facilities that make this extra quality possible—*but it sure saves trouble and money for every HYATT user!* Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER


COMPRESSION
62
This condition of variable stress can be replaced by effective
widths of plate which cooperate with each stiffener and are sub-
jected to the same stress as the stiffener, as determined in the pre-
vious section of this test. The combination is then treated as a
column, the radius of gyration of which is th it about an axis parallel
to the plate.
FIG. 19
STIFFENED FLAT PLATE IN EDGE COMPRESSION

You'll find it all here...

The information you need when designing for high strength steels

OUR new "Design Manual for High Strength Steels" is ready for distribution. Here are 174 pages of practical, authoritative information that you will find invaluable in designing your product for greater economy and efficiency by the sound use of high strength steels. No designer should be without it.

This excellent book covers in detail the problems of tension, compression, shear, beam stress, deformation and deflection. It fully describes the fundamental characteristics of low-alloy high strength steels, shows you how to design against corrosion, describes the application of formed sections. Complete with tables, formulas, and basic data covering this important field of design.

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For your free copy, write on your company letterhead giving your title or department, to United States Steel Corporation, Room 4836, 525 William Penn Place, Pittsburgh 30, Pa.

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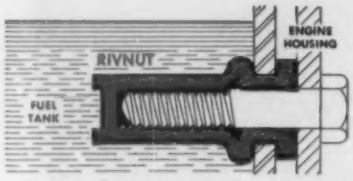
USS HIGH STRENGTH STEELS

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

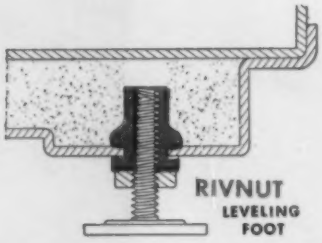
UNITED STATES STEEL

B.F. Goodrich Rivnut

solves practically any fastening problem

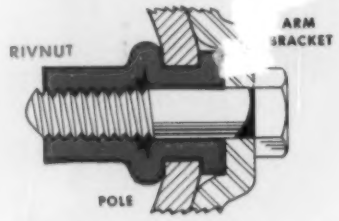


MAKES NUT PLATE, SEAL. Quickly installed in gas tank wall, Rivnut makes firm, accurate nut plate that can't be loosened by shock or vibration. At least six threads are clean for bolt attachment to engine housing. Straps, rivets, braces, nuts are eliminated. Rivnut's special closed end makes 100% gasoline-tight seal.

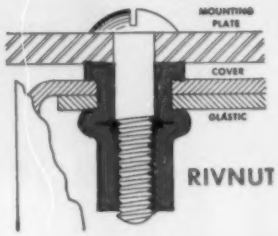


NEW WAY TO FASTEN LEVELING FEET. Appliance manufacturers install Rivnut in metal too thin to tap or weld *after* enameling. Bulge in Rivnut shank (second head) firmly grips the material. At least six threads remain clean to take the leveling foot screw – more than enough to handle the weight of heavy appliances.

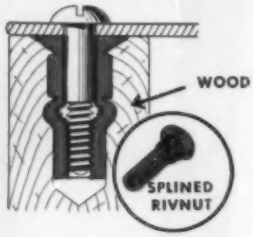
SPEEDS HANDLE ASSEMBLY. B. F. Goodrich Rivnut saves time fastening handle to small appliance. It provides a strong nut plate in *seconds*. Replaces slower fastening methods like nuts and bolts, welding, clinching, tapping. Rivnuts can be installed from one side and the open end types can take an attachment screw from either side.



CUTS ASSEMBLY COSTS 50%. In a street light application, it took two men to fasten the arm bracket to the pole. Then the manufacturer redesigned the unit to use Rivnuts. Now one man can do the job in the same time. Tests show the pole or arm bracket will fail before the Rivnuts.



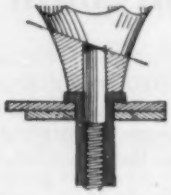
DOES TWO FASTENING JOBS. Rivnuts simplify transformer assembly from start to finish. Starting with unassembled parts, worker fastens sheet of plastic to metal cover with Rivnuts. With cover secured to frame, the Rivnuts then serve as mounting plate.



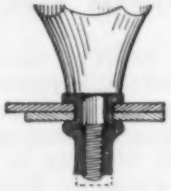
NEW WAY TO FASTEN TO WOOD. Special splined Rivnut for solid fastening in wood eliminates wood screws, provides six metal threads for attachment bolt. Bulge formed in shank holds Rivnut fast. Splined shaft keeps it from turning. Used for bus seats, metal backs in TV sets, etc.

How Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

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Hinged Arm *prevents* Contact Troubles in MALLORY Rheostats

ONE OF THE IMPORTANT REASONS why Mallory Power Rheostats give superior performance is their unique hinged contact arm. Exclusive with Mallory, this construction assures correct pressure at all times, between the brush and the winding. You can lift the arm to clean or replace the brush . . . and the spring snaps back to exactly the right pressure. *The spring carries no current* . . . won't anneal and lose its tension during overloads.

Other notable design features are built into these rheostats. Ceramic insulation for current-carrying members is selected for high dimensional stability. Tough, impervious vitreous enamel protects the winding. Overall design assures good ventilation and cool operation at full ratings.

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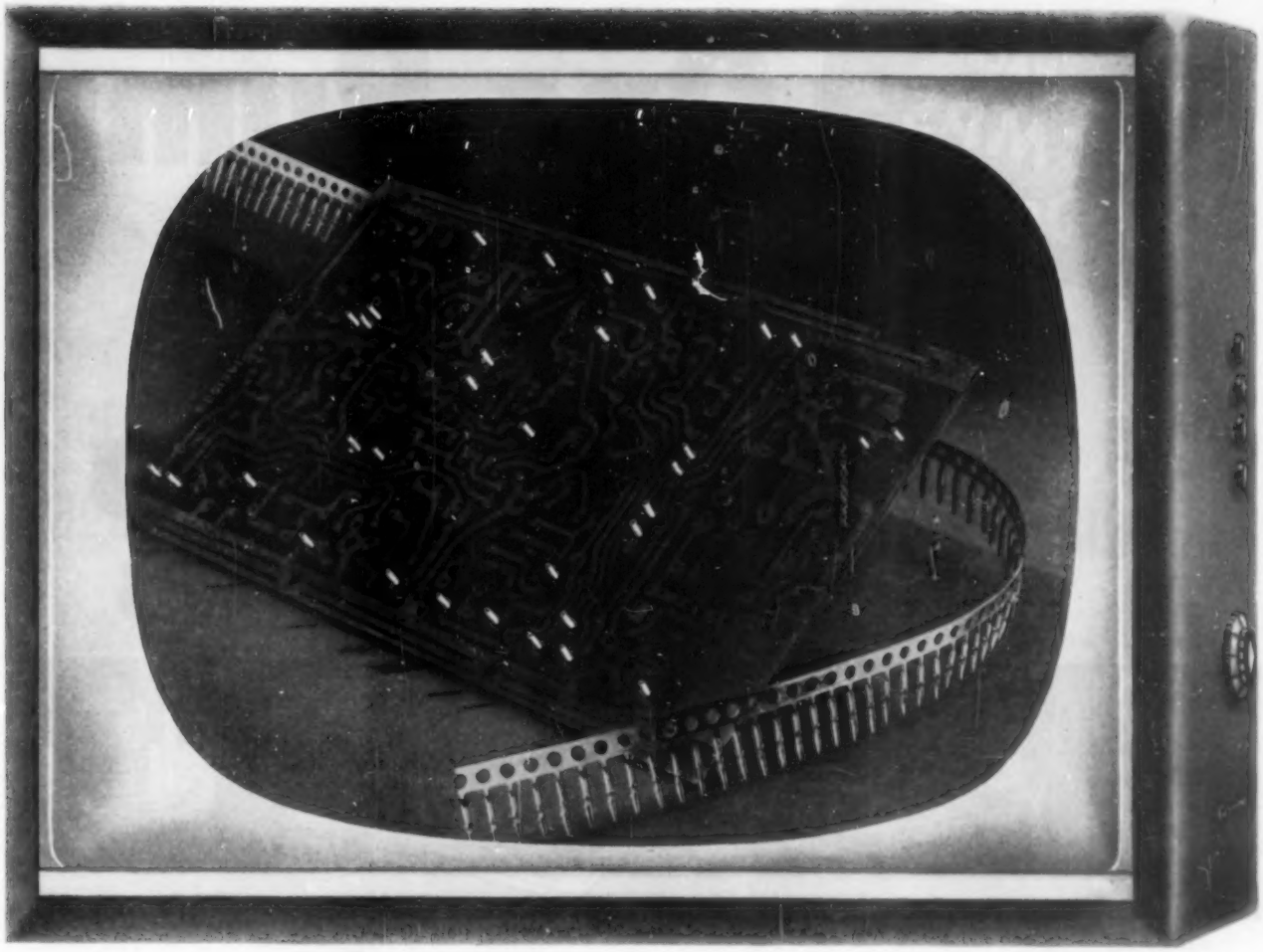

Printed circuit panel courtesy of Admiral Corporation

Brass Snap-in Terminals— key to automatic circuit wiring

Bridgeport High I.Q. Brass permits automatic, high-speed insertion of miniature terminals into printed circuit panels.

Malco Tool and Manufacturing Company of Chicago designed and manufactured these ingenious printed circuit components and the fully automated machines for inserting them into printed circuit panels. To make these precision components for the television, radio and electronic industries, Malco uses Bridgeport's High I.Q. Brass Alloy No. 37. One of the High Inner Qualities of this alloy is its controlled temper —exactly what is needed to meet the critical tension tolerances for this precision machine assembly.

The use of this alloy by Malco is another example of how Bridgeport's High I.Q. alloys are helping to improve products and lower manufacturing costs in a wide variety of industries. To find out how Bridgeport alloys can help in your particular application, call the Bridgeport office near you. They'll give you complete information and the help of Bridgeport's Technical Service on your metals and methods.

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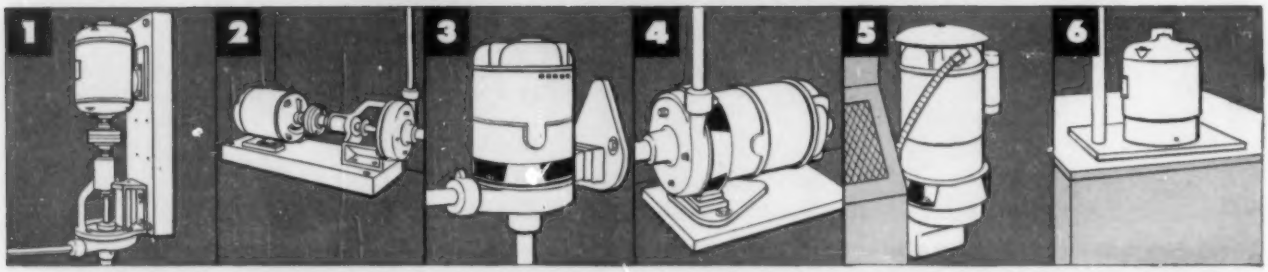
PUMPS for Designers

One Pump 6 Mounting Methods



Base mounted, vertical | Base mounted, horizontal | Close-coupled, vertically mounted | Close-coupled, horizontally mounted | Tank wall mounted | Submerged mounted

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YOU CAN SOLVE MANY DIFFICULT ARRANGEMENT problems easily by standardizing on Allis-Chalmers pumps. You get a single set of operating characteristics in four different models which can be installed six different ways.

Choose the pump for exactly the performance characteristics you need; then use the drive and mounting method best suited to your application. Design problems are simplified . . . designing costs and time reduced.

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Your Allis-Chalmers representative is an experienced, highly qualified specialist who will give you full cooperation every step of the way from drawing board to finished product. Sometimes he can make valuable suggestions which will result in a simpler, more effective product. Next time you have a pump problem, call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

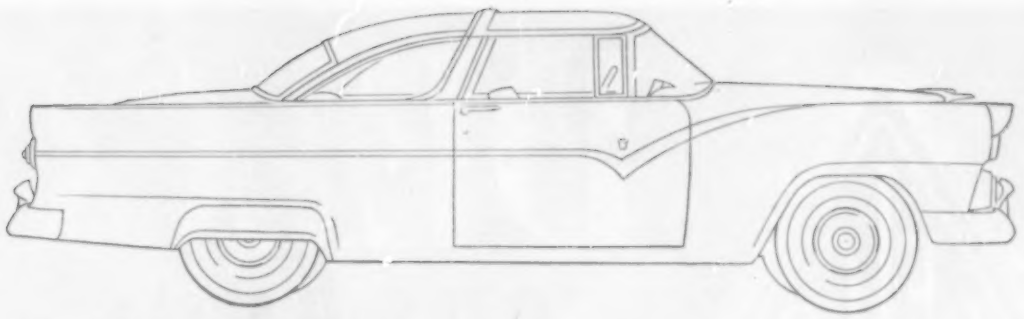
A-4599

Electrifugal is an Allis-Chalmers trademark.

For literature on Allis-Chalmers FHP pumps, ask for bulletins 52B7529 and 52B6691 . . . *Electrifugal* pumps, Bulletin 52B6083 . . . Vertically Mounted pumps, Bulletin 52B6975. Write Allis-Chalmers, Milwaukee 1, Wisconsin.

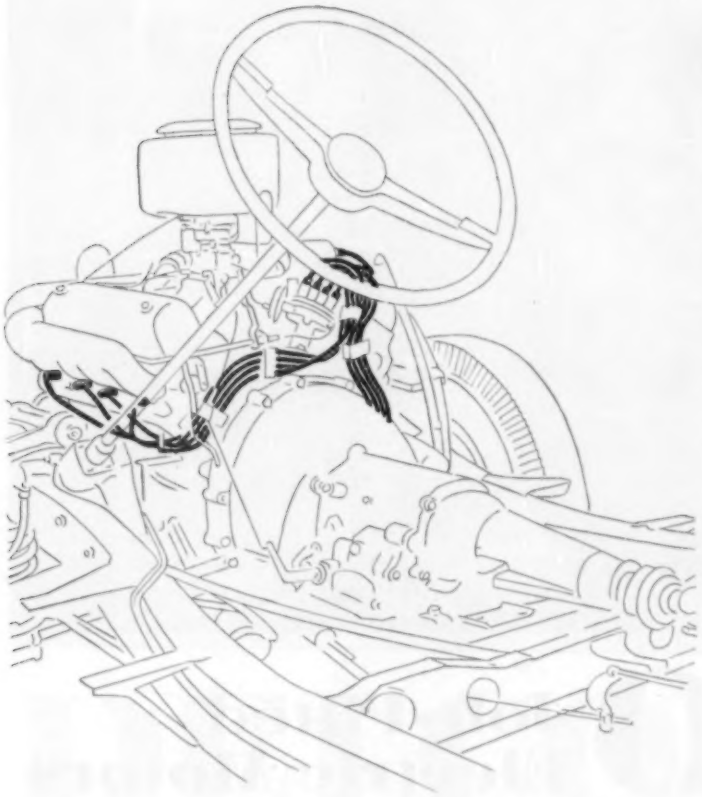
A-C ALLIS-CHALMERS

ALLIS-CHALMERS



Under the hood of the smart new Ford . . .

Neoprene protects ignition wire and spark plugs against moisture . . . resists ozone, heat and oil



Designers made sure the smart-looking 1955 Ford would be off to a fast start in any weather. On both the "Six" and the "Eight" they chose spark-plug covers and ignition-wire jackets made with neoprene for positive protection against moisture and deterioration.

Neoprene covers prevent seepage of moisture to the spark plugs . . . provide instant, all-weather action. And the sturdy neoprene jacket on the ignition wire protects the insulation against heat and oil.

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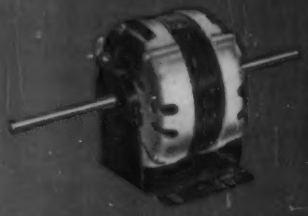
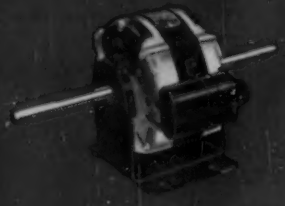
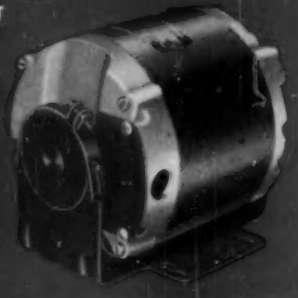


Shaded Pole Motor

Oil Burner Motor



Permanent-Split Capacitor Motor



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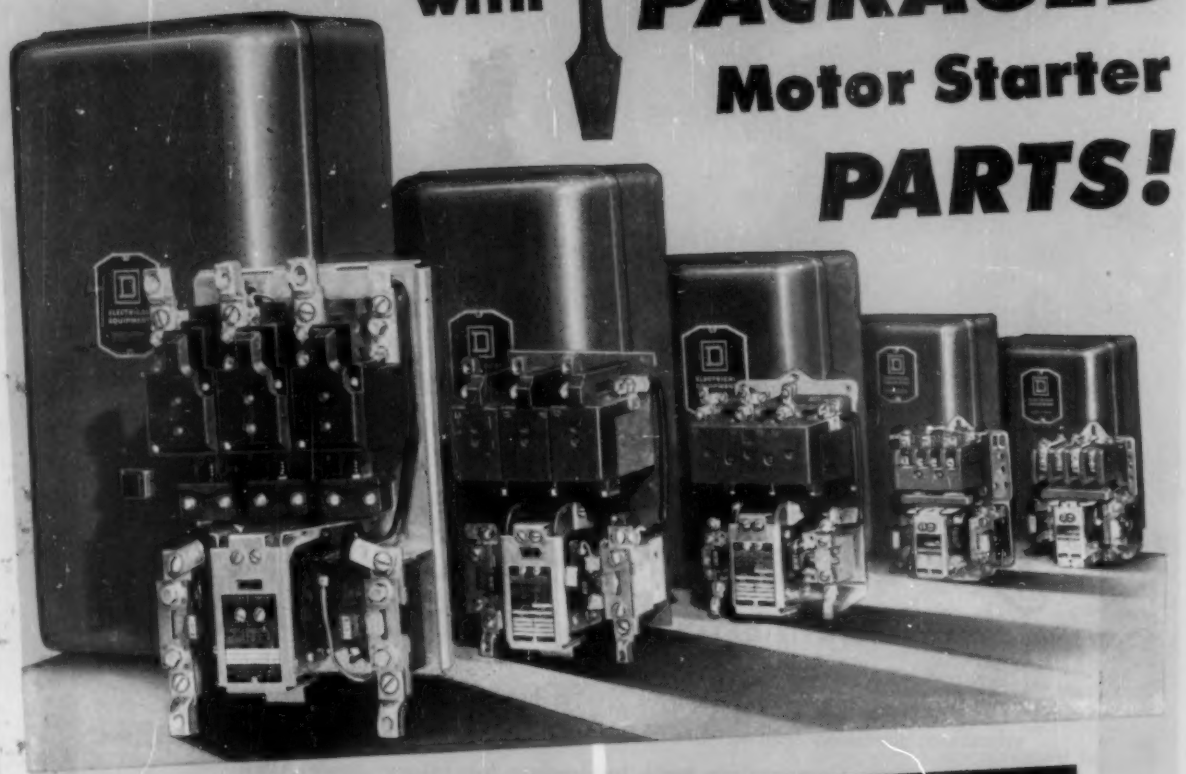

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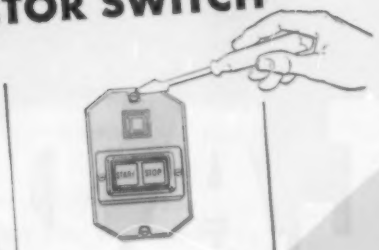
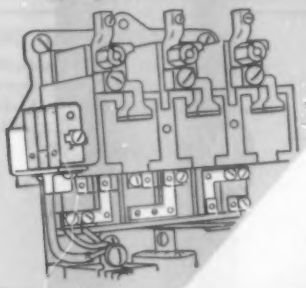


INTERLOCKS

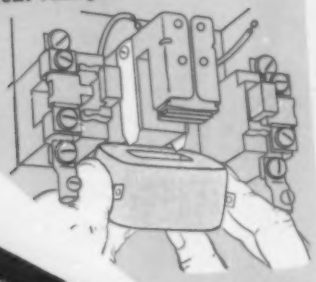
A wide variety of quick-change, front-mounted interlocks adds flexibility for special applications.



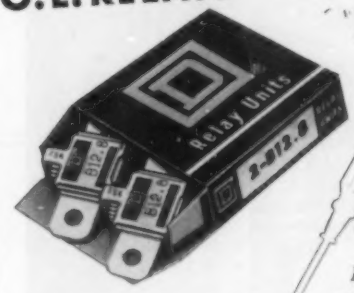
Faster to Install

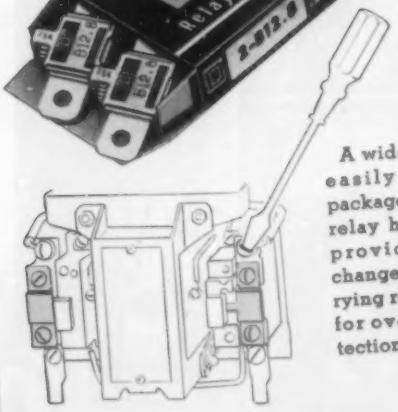
COILS

Screwdriver is only tool required for quick change of magnet coil to accommodate different voltages.



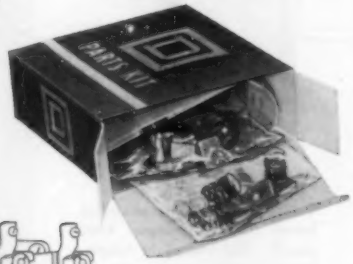
O.L. RELAYS

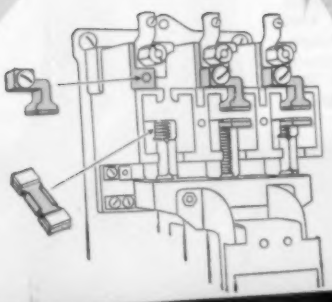




A wide variety of easily selected, packaged overload relay heater units provides quick changes to meet varying requirements for overload protection.

CONTACTS



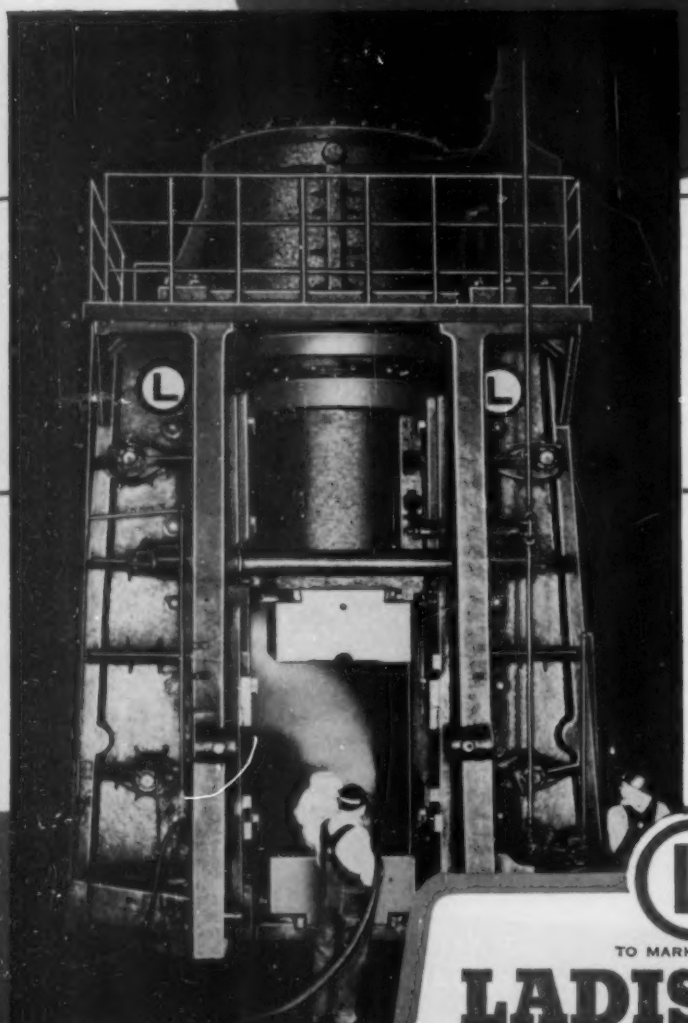


Packaged replacement contacts are easily installed without disturbing wiring.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

LADISH

OFFERS GREATER LATITUDE IN THE DESIGN OF LARGE COMPLICATED PARTS



WORLD'S LARGEST FORGING HAMMER

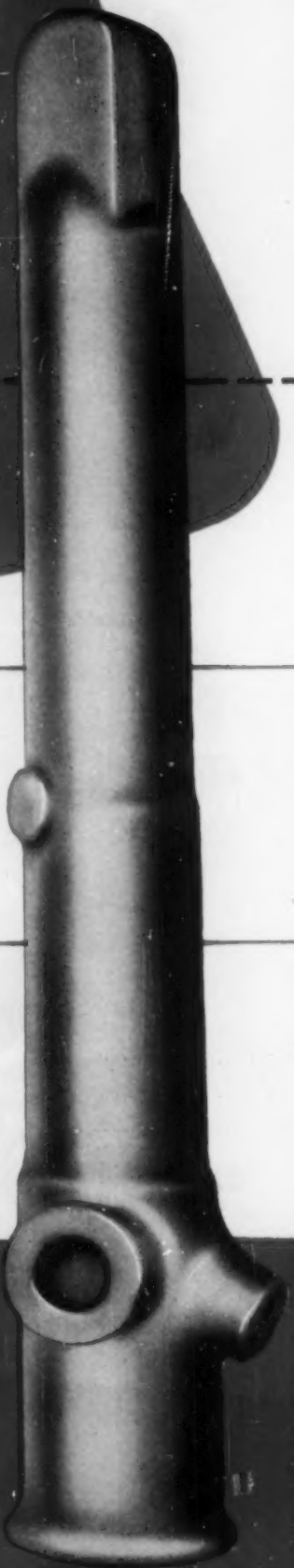
80,000 MKG counterblow forging hammer, the most powerful known in the world, is estimated to be equivalent to 100,000 pound one way steam drop hammer if such were available.

TURBINE BLADES

Forged by Ladish in Titanium and Stainless Steel Alloys to withstand tremendous pressures and temperatures without deformation.

LANDING GEAR

Outstanding example of Ladish heavy drop forgings: 8500 pounds, 132 inches in length. Drop Forging saved material and machining cost for 5000 pounds of Chromium-Nickel-Molybdenum alloy steel.



TO MARK PROGRESS

LADISH CO.

CUDAHY, (Milwaukee Suburb) WISCONSIN

Controlled Quality

DROP FORGINGS UP TO 10,000 POUNDS,
WELDED AND SEAMLESS ROLLED RINGS UP TO 60,000 POUNDS

REGARDLESS OF SIZE, CONTOUR OR MATERIAL...YOU CAN DEPEND ON LADISH

Ladish pioneering in tremendous closed-impression-die forgings offers engineers new freedom in extending the inherent advantages of the drop forging process to intricately shaped parts weighing as much as *10,000 pounds*. Drop Forging close-to-finish dimensions materially reduce metal and machining costs . . . while improvement in dynamic strength and toughness makes possible substantial reductions in dead weight . . . and higher factors of safety.

A discussion of your products with a Ladish forging engineer will provide specific data on the ultimate economy and improvement in design you can impart to your own products by specifying forgings . . . Ladish Controlled Quality forgings.

WITH CLOSED-IMPRESSION-DIE DROP FORGINGS WEIGHING UP TO 10,000 LBS.

TITANIUM PROPELLER BLADE

Again Ladish pioneers with the largest known Titanium forging produced in closed-impression dies. 40% saving in weight realized by forging this 100-inch blade in "wonder metal" Titanium.

DIESEL CRANKSHAFT

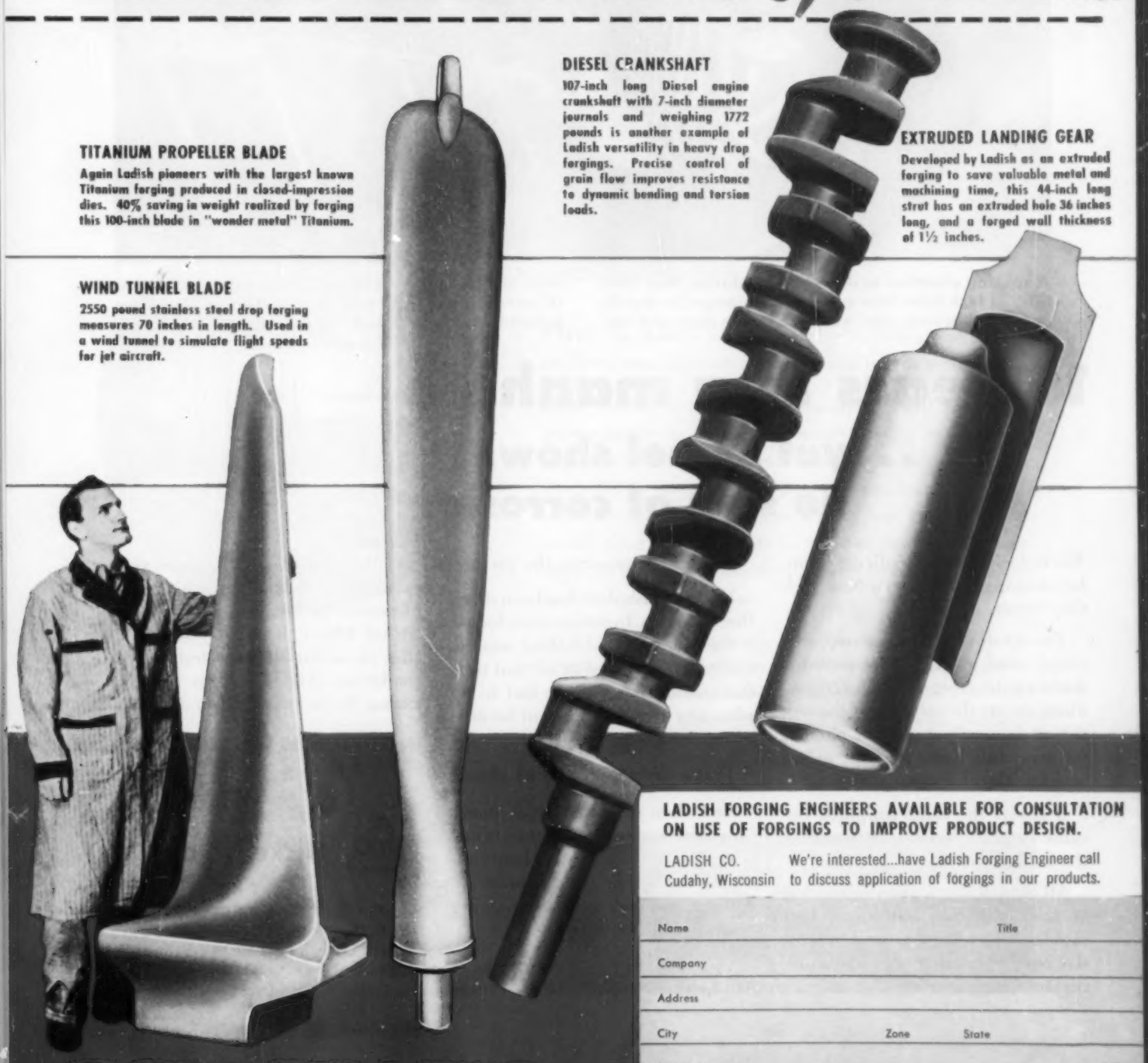
107-inch long Diesel engine crankshaft with 7-inch diameter journals and weighing 1772 pounds is another example of Ladish versatility in heavy drop forgings. Precise control of grain flow improves resistance to dynamic bending and torsion loads.

EXTRUDED LANDING GEAR

Developed by Ladish as an extruded forging to save valuable metal and machining time, this 44-inch long strut has an extruded hole 36 inches long, and a forged wall thickness of 1½ inches.

WIND TUNNEL BLADE

2550 pound stainless steel drop forging measures 70 inches in length. Used in a wind tunnel to simulate flight speeds for jet aircraft.



FOR COMPLETE SERVICE IN FORGINGS

LADISH FORGING ENGINEERS AVAILABLE FOR CONSULTATION ON USE OF FORGINGS TO IMPROVE PRODUCT DESIGN.

LADISH CO.
Cudahy, Wisconsin

We're interested...have Ladish Forging Engineer call to discuss application of forgings in our products.

Name Title

Company

Address

City Zone State

Our Products

PrE

A splicing chamber in downtown Manhattan, New York City. At high tides these cables are submerged in heavily polluted, corrosive river water. The cable racks and supports, and the ladder are Monel. This ladder was installed 16 years ago and is as good as new. The supports were installed 13 years ago and are standing up just as well.

16 years in a manhole

...yet Monel shows no sign of corrosion

You're looking into a splicing chamber, looking down from a New York City Street.

The air down there is damp, corrosive. And at high tides polluted harbor water creeps up underground ducts, covers the cables that connect the city's nearly 4 million phones, its telegraph lines, its vital police and fire alarm systems.

It covers the cable supports, the cable support racks, even much of the ladder you see.

All these fixtures were once made of steel. But they deteriorated so rapidly under these severely corrosive conditions, that they had to be replaced in two or three years.

So Monel came into the picture.

In *this* manhole it has been down there 16 years. In others much longer — the oldest Monel ladder was installed in 1918. And in all that time this customer has *never had to replace any Monel equipment because of failure due to corrosion.*

That's something to think about!

And when you do, think of Monel for equipment used in *your* industry — equipment for service where conditions are severe, and corrosion resistance, strength, and toughness are *musts.*

Send for a copy of *Standard Alloys for Special Problems.* This exceptionally handy booklet gives you examples of the many practical applications for Monel and other Inco Nickel Alloys. It shows you *which* alloy to use for different destructive conditions. And it's yours for the asking. Write Inco for it today.

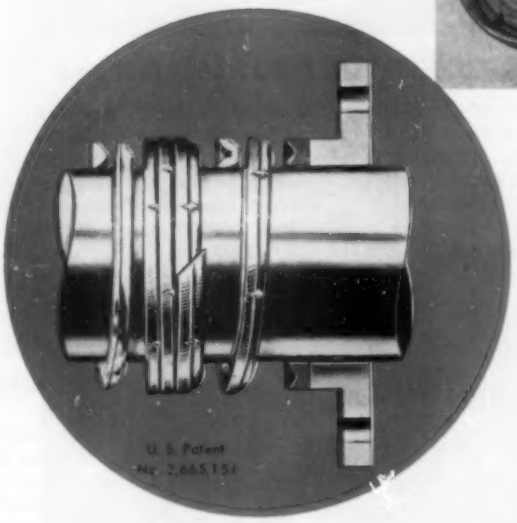
The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N.Y.

INCO TRADE MARK **Nickel Alloys**

Monel® • "R"® Monel • "K"® Monel
"KR"® Monel • "S"® Monel • Inconel®
Inconel "X"® • Inconel "W"® • Incoloy®
Nimonic® Alloys • Nickel
Low Carbon Nickel • Duranickel®

Really leakproof!

Linear VEE-DAM rings



HERE'S A UNIQUE, revolutionary split V-Ring design that positively stops both labyrinth flow and lateral leakage!

LINEAR VEE-DAM RINGS don't require precise fitting. Even when gaps occur at the ring joints, through careless installation or variations in bore size, fluid can't leak past the rings. Here's why: *Sturdy Rubber Dams* (A) in the grooved hinge area hermetically seal off center groove sections. When rings are stacked together, these dams eliminate all labyrinth flow. *External abutments* (B) on the ring shoulders prevent lateral leakage and provide stabilizing support.

Let us show you how LINEAR VEE-DAM RINGS, engineered to your application in a choice of fabric reinforced synthetic rubbers, save you installation and maintenance time, and assure you absolutely leakproof packing over a wide temperature range.

"PERFECTLY ENGINEERED PACKINGS"

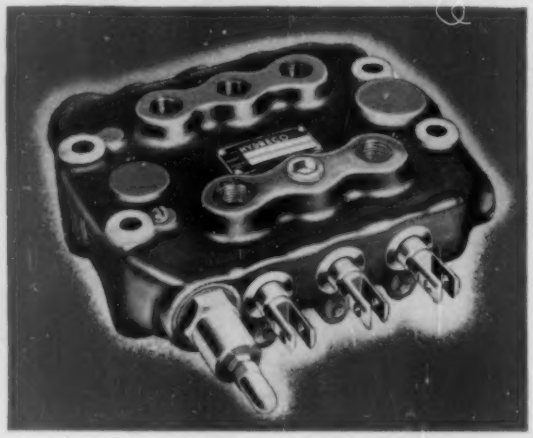
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

PUMPS
MOTORS
ENGINEER'G
VALVES
CYLINDERS

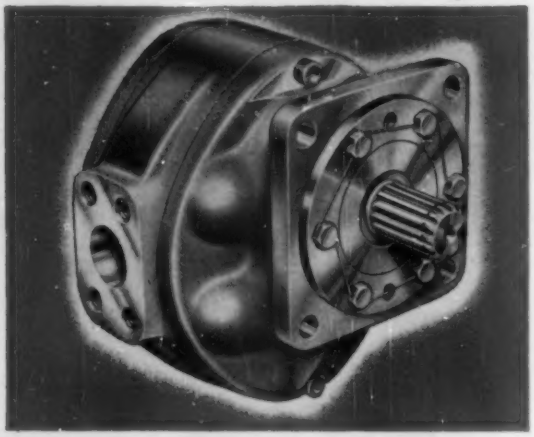
ACCEPT AN UP-TO-DATE FILE ON THESE AND OTHER NEW HYDRAULIC DEVELOPMENTS!

It is certainly true of today's engineering that *"the race is to the swift"*. Advances in hydraulic equipment made by The New York Air Brake Company are too broad and too important to trust in outdated data . . . you need the latest information on the latest developments to keep abreast of the times. New pumps, new motors, new valves and new cylinders . . . many of which dramatically affect design and performance concepts . . . are a MUST for *your* ready reference today. Brochures, data and engineering aid for your present or projected hydraulic circuits are now available.



HYDRECO HOLLOW-PLUNGER CONTROL VALVES

The advancements made by HYDRECO engineering in multiple plunger, single and double acting control valves bring you new, accurate throttling . . . smooth, positive, fingertip control with notable freedom from binding, chattering or troublesome back pressures. Valves with 1 to 6 plungers in capacities from 5 to 100 gpm and operating pressures of 1500 psi are now available for your present and projected equipment.



HYDRECO GEAR-TYPE PUMPS 1000/1500 psi

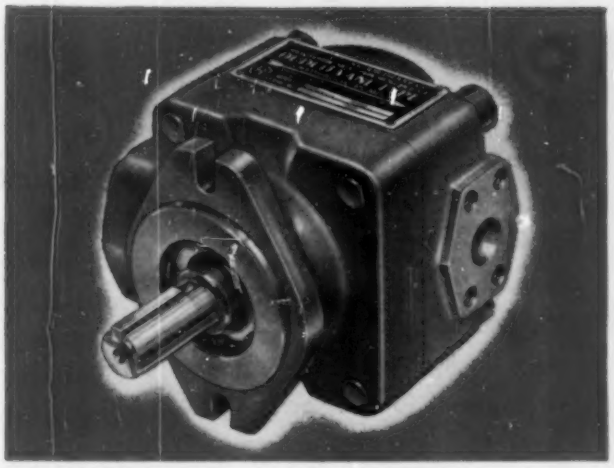
HYDRECO engineers have shattered the illusion that "any gear pump is just a gear pump". New developments in the famous HYDRECO Four-Bolt design provide higher pressures, higher speeds and higher efficiencies than were previously available. You'll want to know more about the many Heavy Duty features in HYDRECO Pumps. A full range of sizes—3.3 to 120 gpm at 1200 rpm.

HYDRECO FLUID POWER MOTORS 1000 psi

For the many applications which call for reversible rotary motion with high starting and running torques . . . HYDRECO Four-Bolt, Gear-Type Fluid Motors are the economical and reliable answer. Precision, ruggedness and simplicity combine to ideally suit these motors to machine tools, oil drill rigs, conveyors, agitators and a thousand other uses. Sizes 3 to 52 hp at 2000 rpm, 1000 psi.

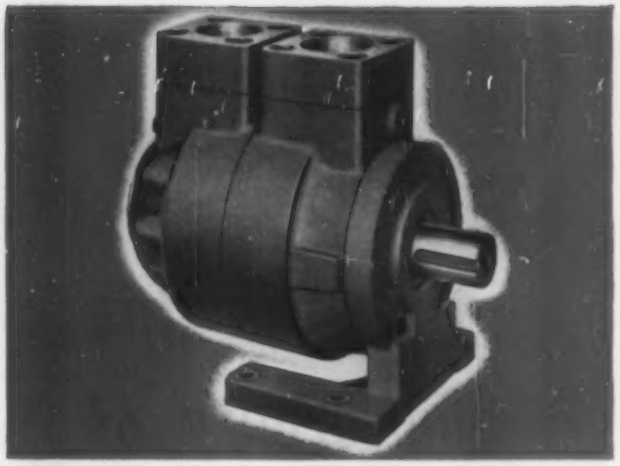
HYDRECO AUXILIARY VALVES 1000/1500 psi

HYDRECO engineers have made very important contributions to the modern hydraulic system in the Relief and Selector Valves now available for your applications. For accurate control over a long service life, HYDRECO Relief Valves in capacities to 100 gpm serve without chatter, squeal or whistle. The Selector Valves enable you to perform additional operations with your system, and these are available in capacities to 50 gpm.



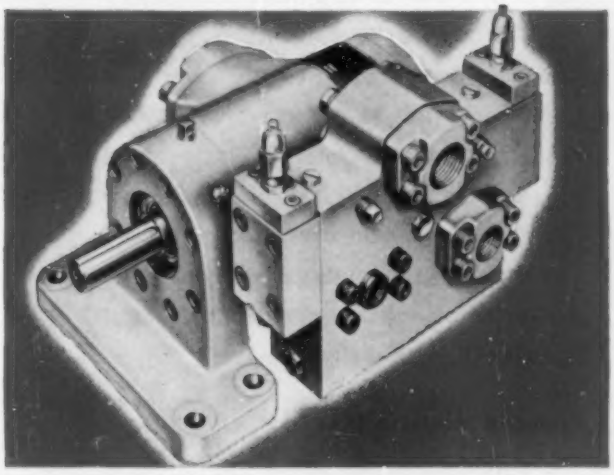
DUDCO DUAL-VANE HYDRAULIC PUMPS 2000 psi

Featuring a simplified 3-unit construction, the new DUDCO PF-100 and PFM-100 Series Pumps, rated at 2000 psi, provide designers with the extra margin of safety which your customers need so badly. The PFM models for heavy duty mobile equipment—the PF models for machine tools, marine, oil field and other industrial applications. The fully balanced DUAL-VANE construction assures high efficiency at higher pressures for continuous operation. Interchangeable Cam Rings add a factor of flexibility that conserves time and money. 3 to 11 gpm at 1200 rpm.



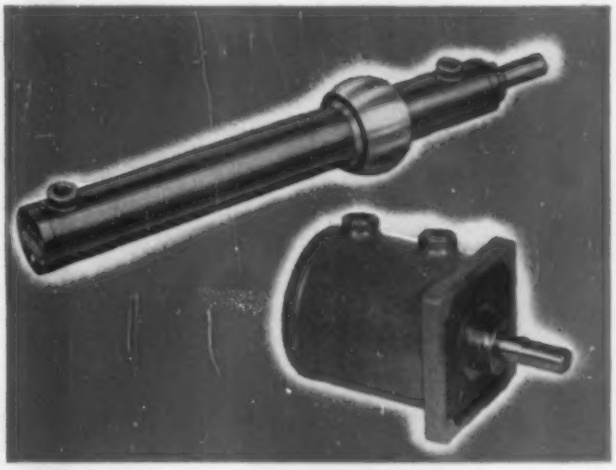
DUDCO DUAL-VANE FLUID MOTORS 2000 psi

DUDCO *Hydraulically Balanced* Fluid Motors utilize the remarkably efficient DUAL-VANE principle to transform fluid power into rotary power with minimized power loss. Operate quietly and smoothly under load with high starting torque. For use in industrial and mobile circuits calling for frequent starting, stopping, and reversing or continuous running at speeds to 3600 rpm. Over 30 standard models for 2000 psi continuous operation . . . actual torque deliveries from 180 to 14,400 lb-in.



DUDCO DOUBLE PUMPS WITH VALVE PANELS 2000 psi

These integral units meet the broad demands of circuits which call for substantial variation in pump volume, such as: "close and hold" or "traverse and feed" cycles. Hydraulic Presses, Plastic Molding Machines and many Machine Tools find these units highly efficient in operation, low in first cost, dollar-saving in reduced piping and valving in the circuit and supremely simple to service. Can be used in the operation of two separate systems or for Hi-Lo circuits.



HYDRECO CUSTOM-BUILT CYLINDERS

HYDRECO Hydraulic Cylinders enjoy an established reputation for quality and dependability. To achieve this degree of dependability entails craftsmanship and manufacturing niceties not practical in so-called standard cylinders built to meet a price. For engineers who seek performance, long-wear under heavy duty conditions and unmatched leakproof qualities, HYDRECO engineering and craftsmanship have something of special interest to offer.

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BOOTH 514

PRODUCTION ENGINEERING SHOW

CHICAGO SEPT. 6-16

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DUDCO 2000 psi Pumps ☐ Pumps and Valve Panels ☐
Motors ☐

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how the uniformity of CENTRAL FOUNDRY shell castings may help you

Uniformity of shell castings* produced by Central Foundry Division from grey iron, malleable iron and Armasteel has many advantages. Complicated cast contours with smooth surfaces are practical. Reduced finish allowances with close tolerances permit lower machining cost and longer tool life . . . and lower casting weights effect savings in freight charges.

Complex Difficult Parts

The shell process is especially effective for the casting of narrow or intricate hydraulic passages. The transmission governor body shown at right was unsatisfactory when produced by die casting, conventional ferrous moulding or machined from a forging. The development of a shell casting by Central Foundry Division solved the problem. Over 120,000 pieces monthly are now being shell cast from grey iron. The machining allowance of 1/32 inch is evidence of the uniformity of Central Foundry Division shell castings.

Reduced Machine Time

The efficiency of machining operations is increased through the use of shell cast parts. Closer casting tolerances result in reduced finishing stock and shorter ma-

*A thin shell of sand bonded by a thermo-setting plastic, forms the mold. This shell has a hard, smooth surface as accurate as the pattern itself, and results in castings with greater uniformity, much closer tolerances, and clean, sand-free surfaces.

chine cycle time. On the combination camshaft and gear shown at right, preliminary rough cuts are not needed and the shell casting goes straight to the final machining operations. The uniformity of Central Foundry Division shell castings permits grinding without the preparatory roughing operations, thus reducing machine time and tool costs in this and many other applications.

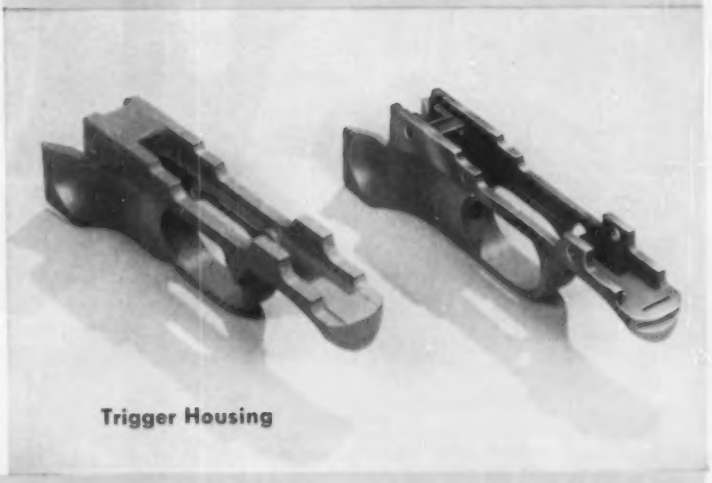
Improved Casting Surfaces

The improved casting surfaces and close tolerances of a shell casting often eliminate machining on non functional areas. Such is the case with the trigger housing of an automatic rifle, shown at lower right. The part was first produced from a forging but is now shell cast of Armasteel. The profile milling necessary on the forged part has been entirely eliminated and only critical dimensions are now machined.

For further information about the shell casting process and how it may improve or effect economies in your product, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

Transmission Governor Body

Combination Camshaft and Sprocket



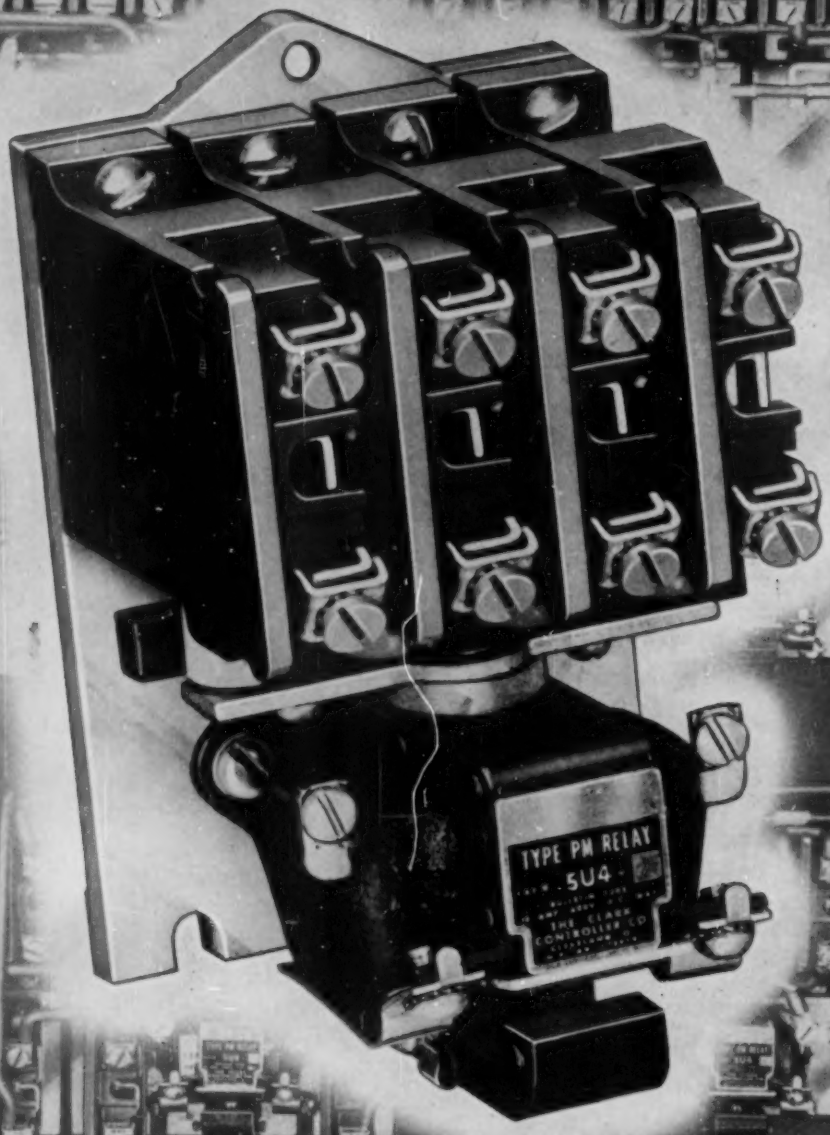
Trigger Housing

52

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

NEW!...



Another CLARK First!

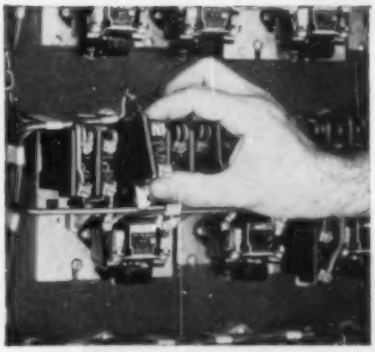
CLARK CONTROL RELAYS

This new line of CLARK Type "PM" magnetic relays introduces a revolutionary new concept in relay design: SECTIONAL POLE CONSTRUCTION. Sectional Pole Construction permits the addition of many advantages not found in any other 10-ampere relay. An outstanding feature is maximum utility of panel space.

• COMPLETE LINE—2 TO 12 POLES

New CLARK Type "PM" Relays feature the most complete range of models, sizes and combinations available in one integrated line. There are specific models to meet virtually all demands of Industry for 10-ampere relays as determined by an extensive study of relay usage. Type "PM" relays are further designed to meet practically every installation condition, panel arrangement or space requirement. Mounting dimensions are universally standard and design uses a minimum number of parts with maximum interchangeability.

• SECTIONAL POLE CONSTRUCTION MEANS HEAVY-DUTY RELAY IN SMALL SPACE



Each pole is an integral unit that can be removed, installed or replaced from the front without disturbing other poles (See illustration). Individual poles are contained in separate melamine housings, forming individual arcing chambers for each set of contacts. A short circuit is confined to one pole and will not destroy the whole relay. The top of the pole is protected by a melamine cover—molded in one piece with the side—preventing failure from dust and dirt, and serving as a space-saving wiring shelf.

• ALL WIRING AND MAINTENANCE —FROM THE FRONT

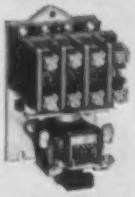
All terminals and pole-mounting screws are on the *front* where they are easiest to get at. Only two wires and one mounting screw to remove when replacing a pole. Contacts can be inspected from the front. They can be quickly and easily converted from normally open to normally closed and vice versa. Coil-changing or magnet replacement can be done from the front without removing the relay from the panel. Only 7/8 inches clearance required below relay for coil replacement.

• PRE-ASSEMBLED POLE AND MAGNET KITS —AVAILABLE FOR QUICK MAINTENANCE

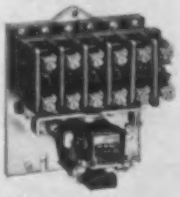
Extra pole assemblies for all models are available in packaged kits—either normally open or normally closed—a big time saver for maintenance men. Clearly labelled packaged coils and complete magnet assemblies are also available in kit form.

SEE THIS NEW RELAY at The Clark exhibit, PRODUCTION ENGINEERING SHOW, Booth 840, Navy Pier, Chicago September 6-16, 1955

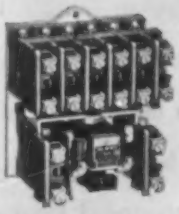
10 STANDARD RELAYS FROM 6 BASIC MODELS



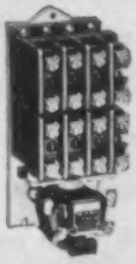
Catalog No. 5U4
Standard 4-pole relay. With one or two poles removed, this model becomes the standard 3 or 2-pole relay respectively.



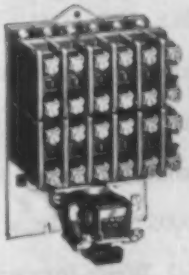
Catalog No. 5U6
Standard 6-pole relay. Poles are interchangeable with 4-pole relay. Mounting dimensions are the same—lining up perfectly when mounted side-by-side with 5U4.



Catalog No. 5U8
Standard 8-pole relay made by mounting 2 poles beside magnet on 5U6. This is the *first 8-pole relay available with single deck wiring.*



Catalog No. 5UK8
Alternate 8-pole relay with double-deck construction—designed to fit perfectly when mounted side-by-side with 10 and 12 pole relays and NEMA standard size 1 starters.



Catalog No. 5U12
Compact double-deck relay for 12-poles. Mounting dimensions identical with NEMA standard size 1 starters. With 2 poles removed, this becomes the standard 10-pole relay.

Catalog No. 5UK2
Alternate 2-pole relay designed to meet small or unusual space requirements. Less than 3 inches overall height.

Write for 8-page illustrated bulletin giving complete information about this revolutionary new CLARK "PM" RELAY line.

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

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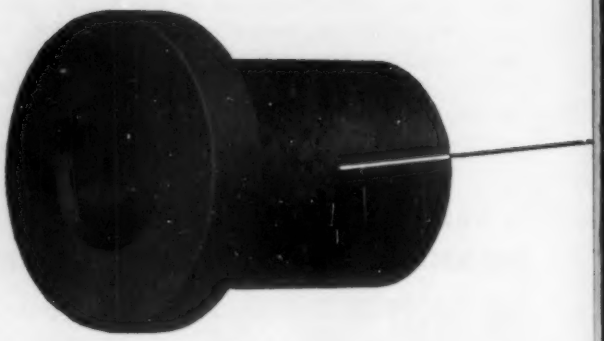
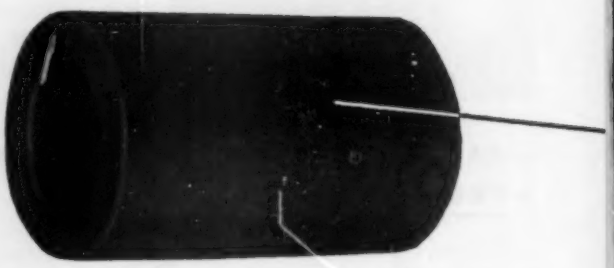
GRAPHITAR® BUSHINGS IN VIKING

(CARBON-GRAPHITE)





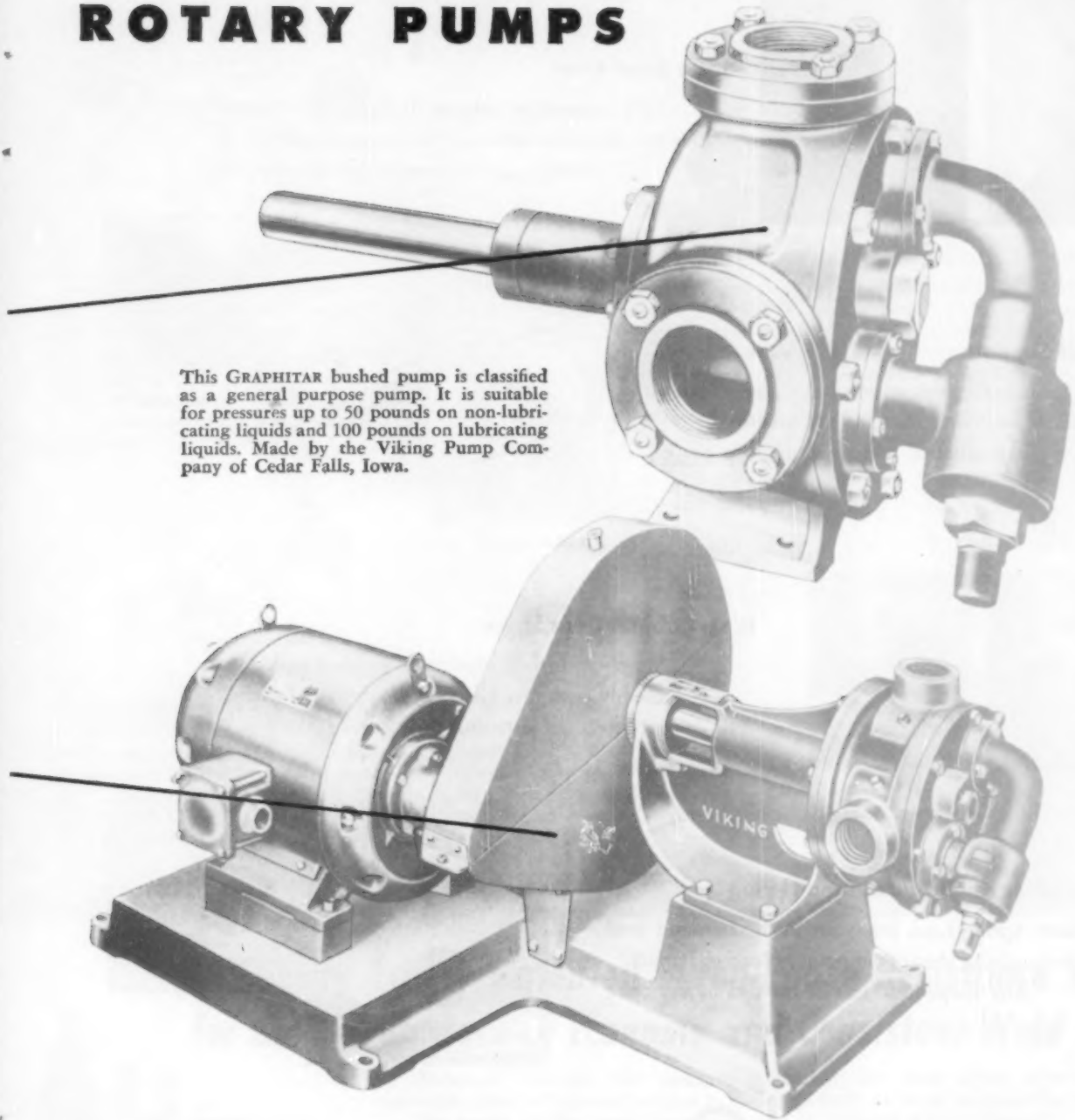
One of the features that accounts for the popularity of these two Viking rotary pumps is the fact that they require no outside lubrication of any kind. GRAPHITAR bushings make this possible. The only lubrication needed by the GRAPHITAR bushings is the liquid being pumped, (even LP-Gas). GRAPHITAR is compounded from carbon-graphite powders compacted under heavy pressure and furnaced at temperatures approaching 4500°F. Because of their composition and method of manufacture, GRAPHITAR parts are chemically inert (will withstand highly corrosive acids), will not warp and are extremely long-wearing. GRAPHITAR combines strength with lightness, and is virtually unaffected by high speeds or pressures or temperatures. It can be formed in relatively complex shapes and ground to tolerances as fine as .0005". In short, a really versatile engineering material. Write for our illustrated catalog.

OUR 101ST YEAR

THE UNITED STATES

NEED NO LUBRICATION

ROTARY PUMPS



This GRAPHITAR bushed pump is classified as a general purpose pump. It is suitable for pressures up to 50 pounds on non-lubricating liquids and 100 pounds on lubricating liquids. Made by the Viking Pump Company of Cedar Falls, Iowa.

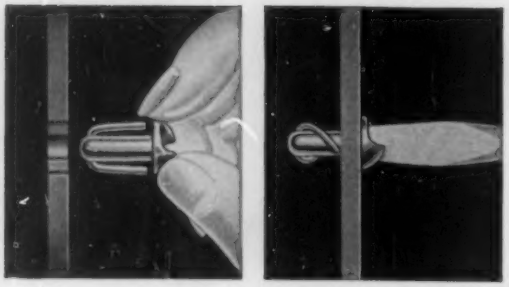
The unusual properties of GRAPHITAR suit it well for use as bearing and mechanical seal in this Viking heavy-duty pump capable of handling 100 pounds pressure on non-lubricating liquids and 200 pounds on lubricating liquids.

205

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Have you a similar use for this 1-piece fastener?

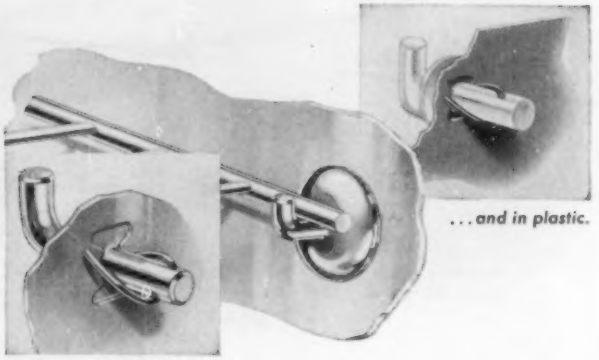


It's a Blind Rivet

...Or a removable fastener. It locks and unlocks with a 90° clockwise rotation. No mating parts such as nuts or receptacles are required.

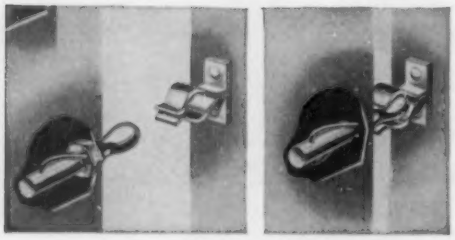
It's a Shelf Support

...For ranges or refrigerators—in plastic and metal. Leading appliance makers have achieved substantial installation savings through its use.



...and in plastic.

Both in metal...

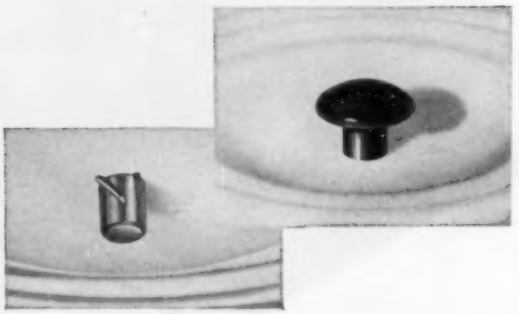


It's a Cabinet Door Strike

...Simple to install; eliminates welding and cuts assembly cost. Any head can be designed without affecting fastening principle.

It's a Lifter Knob or Dashboard Plug

...Plastic Spring-Lock heads are molded around steel inserts, giving strength at point of load or impact. Any shape head can be molded in any color.



What's Your Application?

...Tell us how you can use Spring-Lock Fasteners in your products. We'll be glad to work out the details with you.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS SEND FOR IT!

SIMMONS FASTENER CORPORATION
175 NORTH BROADWAY, ALBANY 1, N. Y.

PRODUCT SALEABILITY IS A BASIC REQUIREMENT OF SUCCESSFUL DESIGN

Resistance welding helps you improve your product design

STRENGTH

Resistance welds are stronger than either of the metals welded together. After 10 years of exhaustive tests no other joint survived, practically all automobile manufacturers have adopted resistance welded wheels. The wheels are made with 8 spot welds instead of the 12 conventional rivets . . . using Sciaky equipment.

RESISTANCE TO CORROSION

Resistance welding leaves no exposed metals to corrode, because the weld is within the metals. There are no holes and the joint is tight. However, tight fit-up cannot always be maintained for riveted joints or rivet heads. The result is penetration of atmospheric moisture and corrosion.

LACK OF DISTORTION

Properly applied, resistance welding practically eliminates warpage and distortion. Thus, costly jigs and fixtures to reduce distortion are not necessary on products designed for resistance welding. However, fusion welding produces considerable distortion and does require the extra expense of related fixturing.

LEAKPROOF

With resistance welding there is no hole . . . thus it is leakproof. Actually, resistance welding is commonly used to make gastight seams. However, riveted assembly is inherently subject to leakage. Not only costly to make leakproof, it is sometimes even impractical.

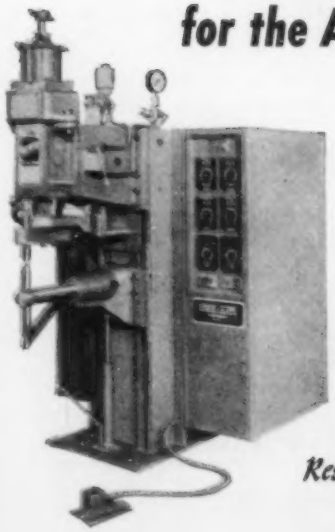
REDUCTION OF WEIGHT

Nothing is added to make a resistance weld—no rod, flux, rivets, etc., are needed. The parent metals themselves are fused together. Resistance welding a product provides a considerable savings in weight compared to riveting, or other forms of welding.

IMPROVED APPEARANCE

Resistance welded spots can be made practically invisible. They need not mar exterior surfaces as do other forms of welding or riveting. Surfaces requiring smooth finish and attractive appearance are best designed for fastening with resistance welding.

Specify Sciaky Patented Three-Phase Resistance Welding for the Advantages of Economy and Consistent Weld Quality



Pioneered, invented, and patented by Sciaky, the three-phase principle of welder operation allows a balanced current to be drawn from all three phases of the power supply.

The result is the lower operating cost of reduced power demand . . . the lower installation costs of smaller switch gear and smaller distribution lines . . . and the consistency of suitable weld quality under high production conditions. For detailed explanation of these and other impressive advantages of Sciaky patented Three-Phase operation, write for Bulletin 332.

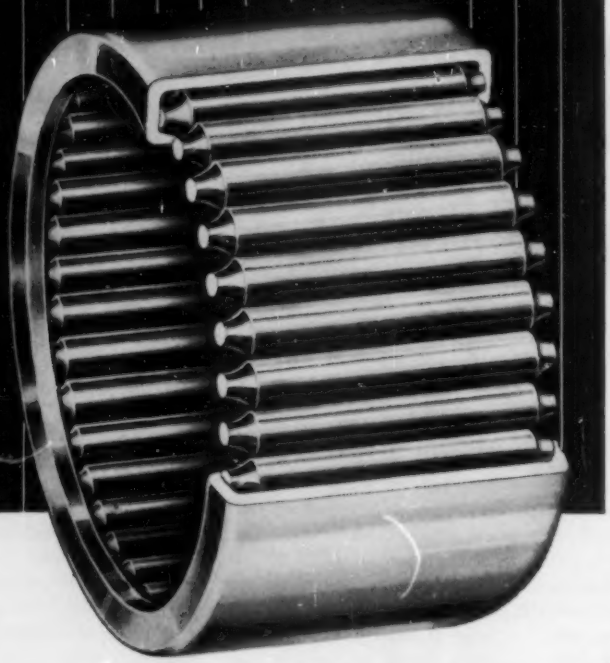
Detailed examples of Sciaky resistance welding applications are available in regular issues of "Resistance Welding at Work." Read how other companies large and small have improved their product and lowered fabricating costs. Send your name and title on company letterhead for these impressive examples of Sciaky's basic thinking—welders designed to do *more useful work* at *lower operating costs* with *maximum reliability.*

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY®

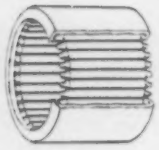
Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

here's why...

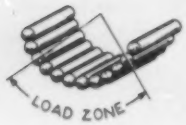


TORRINGTON

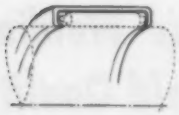
DC needle bearings give high-capacity performance in minimum space



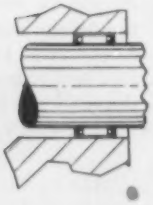
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.



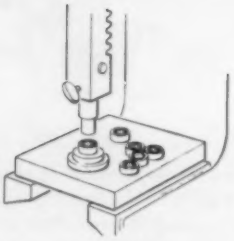
Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.



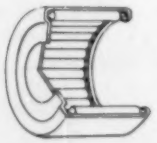
Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.



No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.



Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

THE TORRINGTON COMPANY

Torrington, Conn. **South Bend 21, Ind.**

District offices and distributors in principal cities of United States and Canada

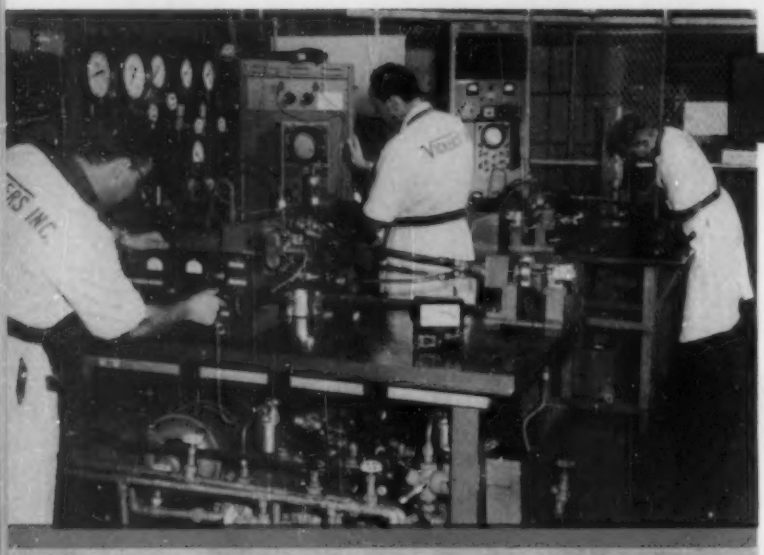
TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

These 54 COMPANIES Use VICKERS® HYDRAULICS on Machines They are Exhibiting at the MACHINE TOOL SHOW

Why VICKERS HYDRAULICS PREDOMINATES on Modern Machine Tools

The large number of Vickers-equipped machine tools that you will see in the Show is no accident. It is due to wide recognition of the many advantages of Vickers Oil Hydraulics. Some important reasons behind this preference for Vickers are mentioned here. There are many more . . . the nearest Vickers Application Engineer will be glad to discuss them with you.



LONG-ESTABLISHED QUALITY

Vickers leadership in quality is the summation of many things. Important among these is the program of continuous research that has been maintained through the years and has resulted in a long and impressive list of pioneering developments. Representative of these are: Hydrostatic Relief Valve . . . Balanced Vane Type Pump . . . Flow Control Compensator . . . Axial Piston Pump and Motor. These, and many other developments by Vickers during more than three decades, have contributed substantially to the advancement of hydraulics for machine tools.

FACTORY-TRAINED APPLICATION ENGINEERS

Thoroughly trained in all phases of oil hydraulics at Vickers plants, this large group of salaried men is exceptionally well qualified to help make hydraulics more useful. They command the wealth of Vickers Hydraulics resources to perform many services . . . from complete circuit design to helping get the "bugs" out of a prototype machine.

Be Sure to See the VICKERS Exhibit at the Machine Tool Show, Booth 814.

STANDARD VICKERS UNITS CAN BE COMBINED TO *Economically* PROVIDE EVERY HYDRAULIC POWER and CONTROL FUNCTION

Single Stage Balanced Vane Type Pump . . . the most widely used of all pumps in oil hydraulic service.

Two-Pressure Pump automatically delivers larger volume at low pressure and smaller volume at high pressure.

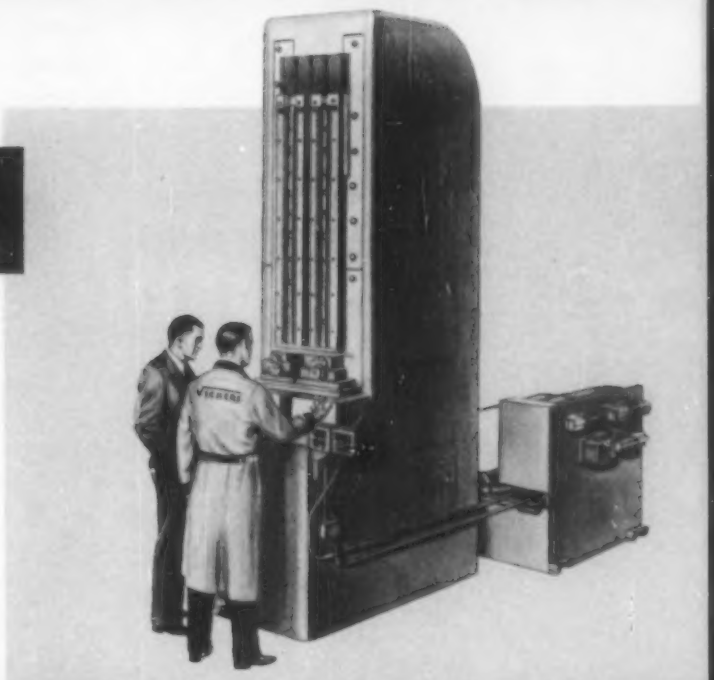
Variable Delivery Axial Piston Type Pump has low inertia forces, higher rotative speeds and very high efficiency.

Power Unit is a compact self-contained power source that frequently results in design simplification and cost savings.

Balanced Piston Type Relief Valve more accurately controls system operating pressure and protects against overload.

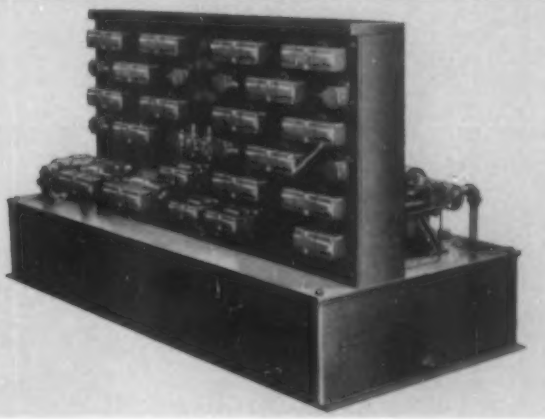
"Hydrocushion" Type Pressure Control Valve for control of unloading and sequence of oil flow in hydraulic system.

Why VICKERS HYDRAULICS PREDOMINATES on Modern Machine Tools



FACTORY-TRAINED FIELD SERVICE SPECIALISTS

Vickers equipment is designed and built to hold service requirements to an irreducible minimum. But no machinery built by man escapes service completely. When Vickers equipment requires service, it is handled by full-time Field Service Specialists working out of Vickers offices from coast to coast. These men, carefully trained in Vickers plants, are thoroughly competent to adjust and maintain all Vickers equipment . . . and qualified to instruct customers' service organizations in improving their own hydraulic maintenance practices.



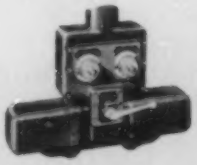
UNDIVIDED RESPONSIBILITY

Many machine builders prefer to use Vickers hydraulic equipment exclusively because it gives them the advantage of undivided Vickers responsibility. Since 1921, Vickers has accumulated a great store of specialized knowledge in hydraulics . . . has developed the extensive line of equipment needed to take undivided responsibility. With Vickers equipment throughout, there is no risk of incompatibility of hydraulic components . . . optimum operation is assured.

For further information, ask for <u>new</u> Catalog 5001A.

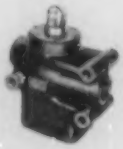
STANDARD VICKERS UNITS CAN BE COMBINED TO *Economically* PROVIDE EVERY HYDRAULIC POWER and CONTROL FUNCTION

Adjustable Flow Control Valve that eliminates jumping and speed variation because of load change.



Traverse and Feed Cycle Control Panel provides any sequence of rapid advance, adjustable feed, dwell and rapid return.

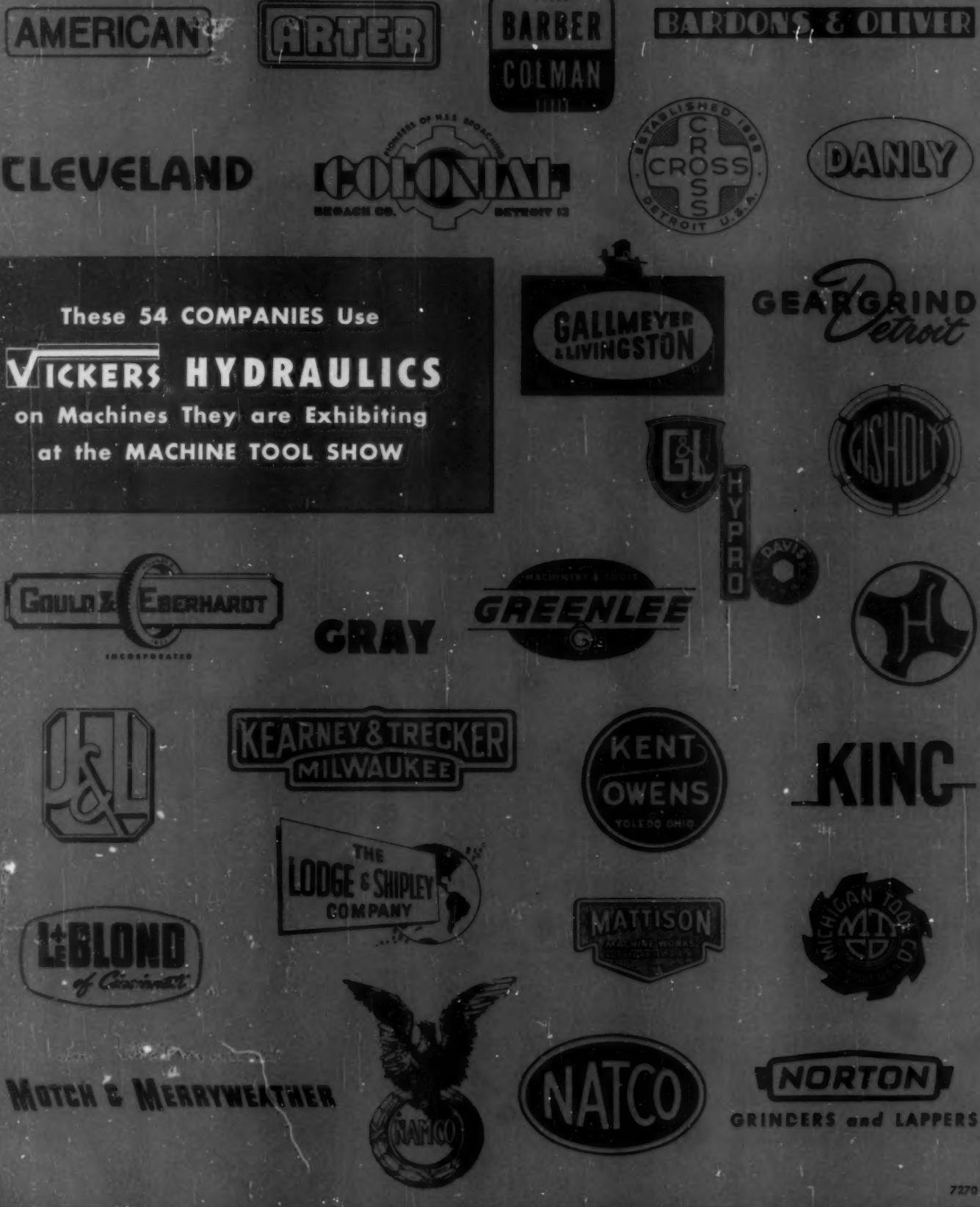
Solenoid Controlled Pilot Operated 4-Way Valve for controlling direction of oil flow remotely and electrically.



Deceleration Valve smoothly diminishes (or increases) oil flow as cam mechanism depresses the valve plunger.

Vane Type Hydraulic Motor has hydraulic balance, high efficiency and exclusive "rocking-beam" construction.

"Compact" Hydraulic (Oil) Cylinder has piston rings or improved cup seals and is available in 5 standard mountings.



VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

1400 OAKMAN BLVD. • DETROIT 32, MICH.

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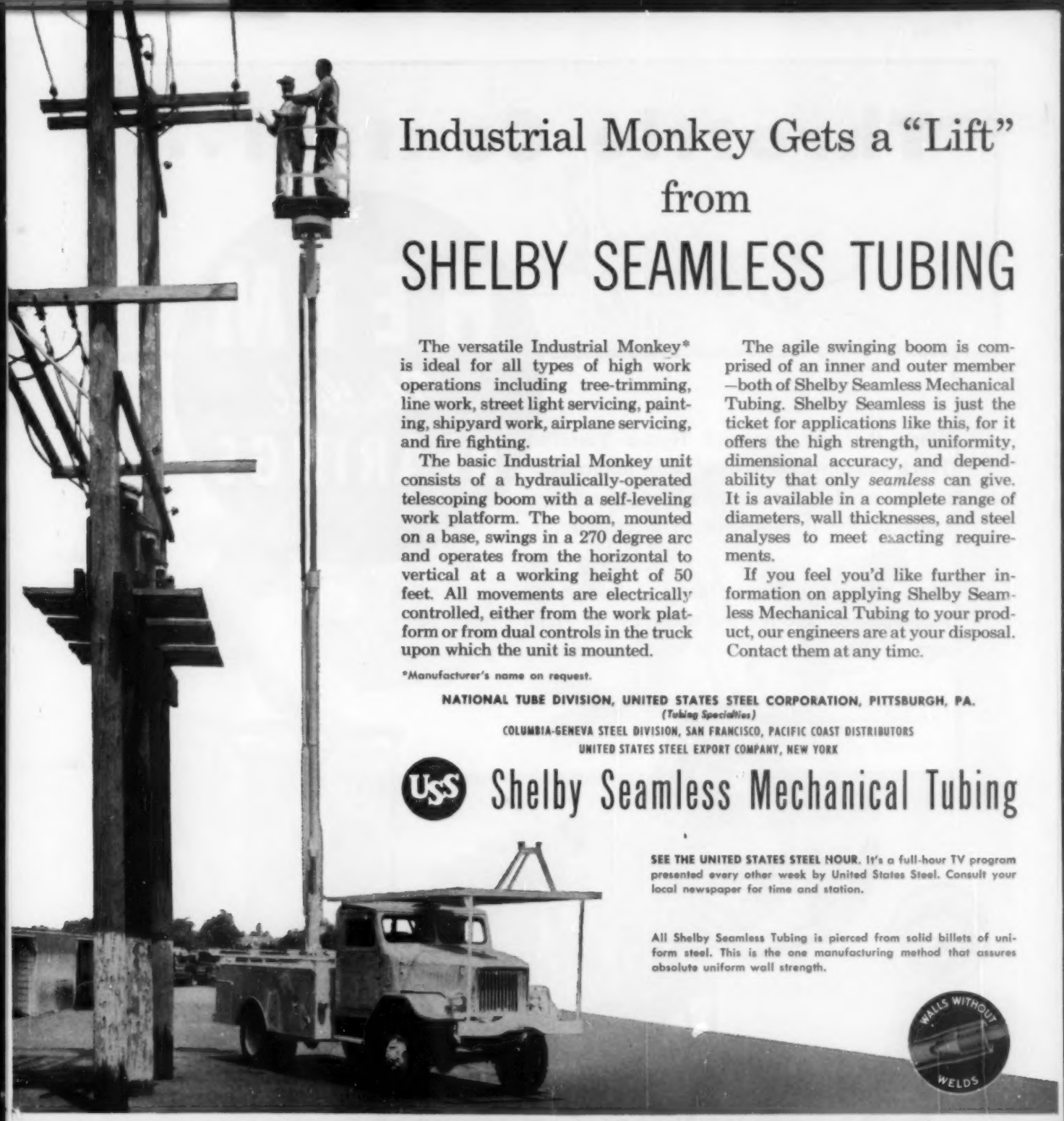


Industrial Monkey Gets a "Lift" from SHELBY SEAMLESS TUBING

The versatile Industrial Monkey* is ideal for all types of high work operations including tree-trimming, line work, street light servicing, painting, shipyard work, airplane servicing, and fire fighting.

The basic Industrial Monkey unit consists of a hydraulically-operated telescoping boom with a self-leveling work platform. The boom, mounted on a base, swings in a 270 degree arc and operates from the horizontal to vertical at a working height of 50 feet. All movements are electrically controlled, either from the work platform or from dual controls in the truck upon which the unit is mounted.

The agile swinging boom is comprised of an inner and outer member —both of Shelby Seamless Mechanical Tubing. Shelby Seamless is just the ticket for applications like this, for it offers the high strength, uniformity, dimensional accuracy, and dependability that only *seamless* can give. It is available in a complete range of diameters, wall thicknesses, and steel analyses to meet exacting requirements.

If you feel you'd like further information on applying Shelby Seamless Mechanical Tubing to your product, our engineers are at your disposal. Contact them at any time.

*Manufacturer's name on request.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS Shelby Seamless Mechanical Tubing

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

WALLS WITHOUT WELDS

UNITED STATES STEEL

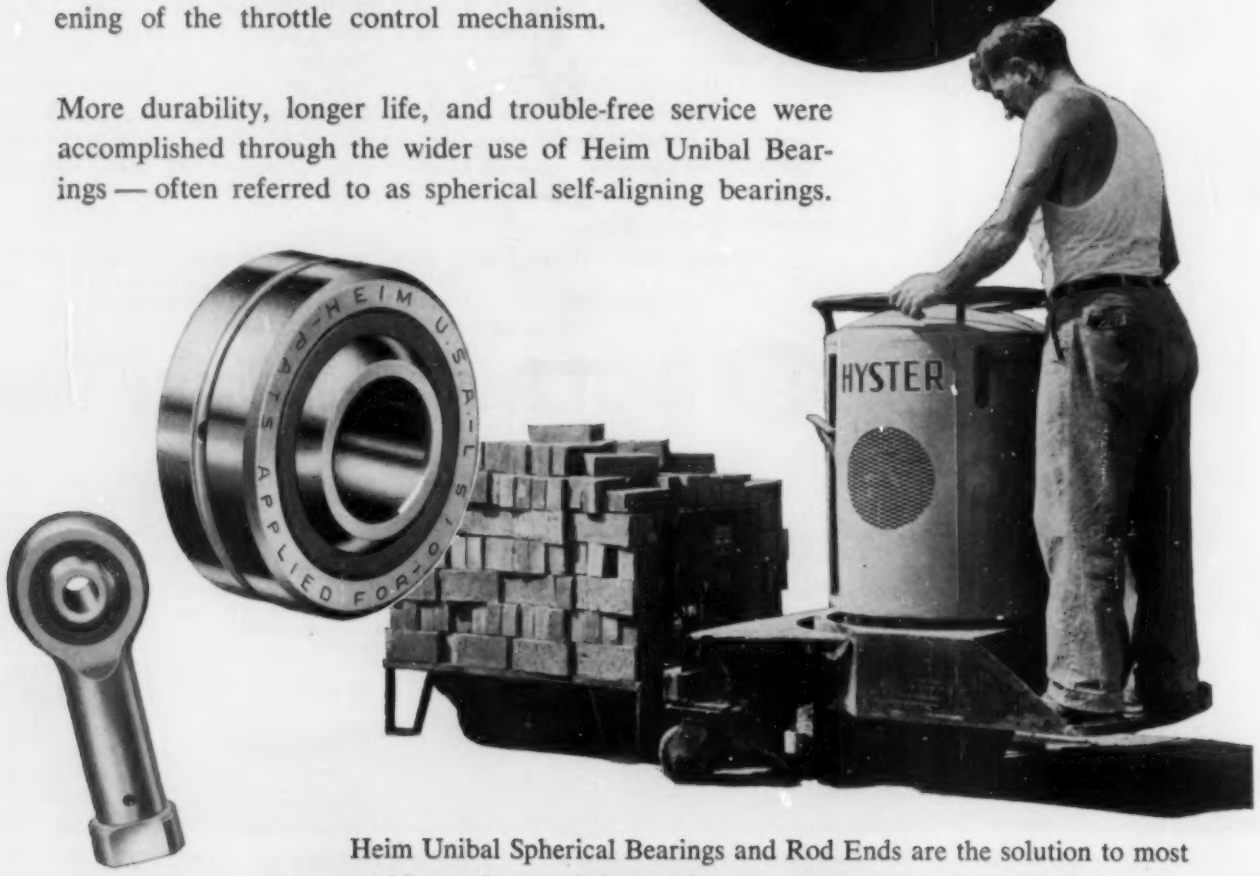
Throttle Control...

Simplified with

HEIM *Unibal* BEARINGS

When the new improved Hyster Turret Truck was introduced, some of the improvements included simplification and strengthening of the throttle control mechanism.

More durability, longer life, and trouble-free service were accomplished through the wider use of Heim Unibal Bearings — often referred to as spherical self-aligning bearings.



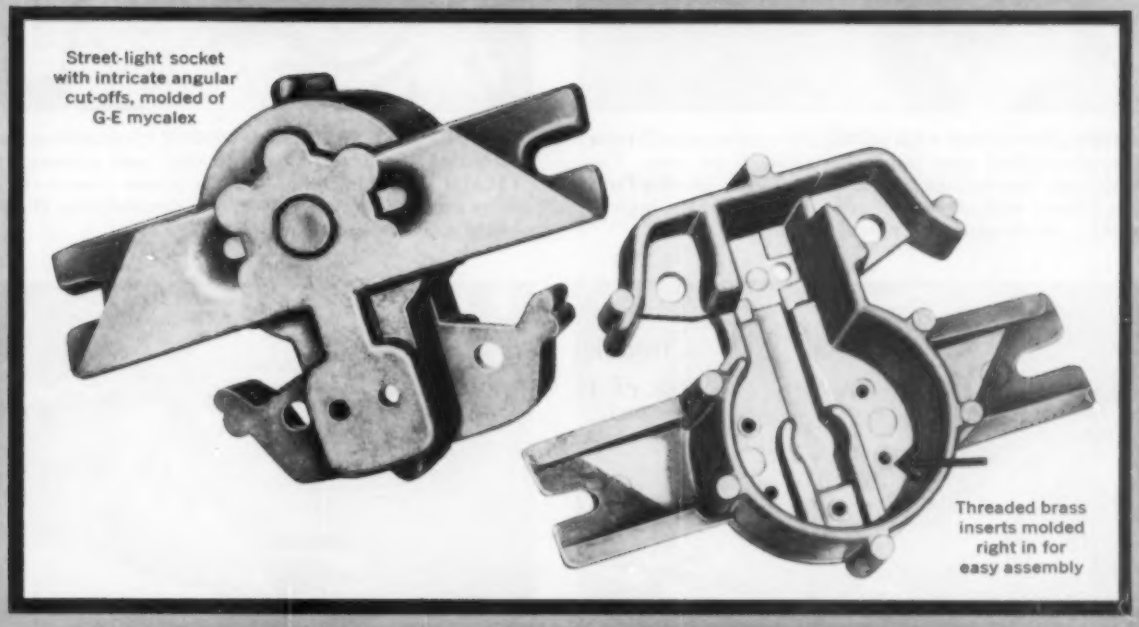
THE SINGLE BALL CORRECTS MISALIGNMENT IN EVERY DIRECTION.

Heim Unibal Spherical Bearings and Rod Ends are the solution to most problems of transmitting motion at varying angles. Rod Ends are available in a complete range of bore and thread sizes in both male and female types.

Write for Complete Catalog and a free sample of Unibal.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Another new product... made better (at lower cost, too) with G-E mycalex parts


Street-light socket with intricate angular cut-offs, molded of G-E mycalex
Threaded brass inserts molded right in for easy assembly

NOW YOU CAN SPECIFY G-E MYCALEX for extremely intricate parts! This street-light socket, for example, shows how General Electric's Plastics Department molds this high-dielectric insulating material into truly complex shapes. Note the angular cut-offs—how inserts are molded right in! Using G-E mycalex rather than more costly conventional materials, the customer was able to obtain this part at a considerable reduction in cost. Additional savings were also made possible through the molded-in inserts and closer tolerances for faster assembly!

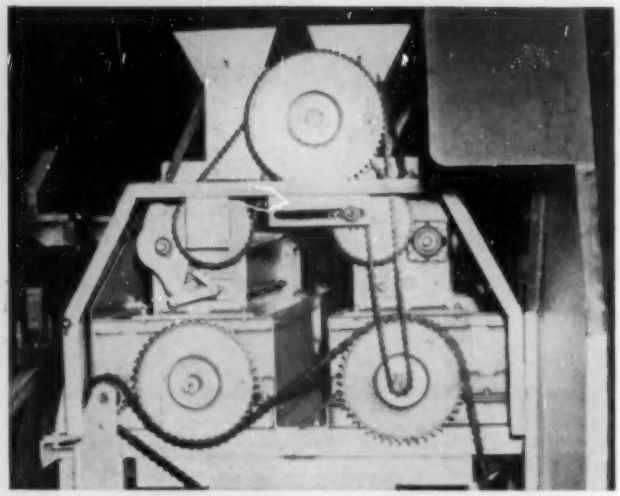
Have you a product which could be made better—with G-E mycalex parts? Let G-E plastics engineers show you how to get the benefits of G-E mycalex properties and cut costs at the same time!

Write: Plastics Department, General Electric Company, Pittsfield, Mass.
Plants at Decatur, Illinois—Taunton, Massachusetts **550-4B**

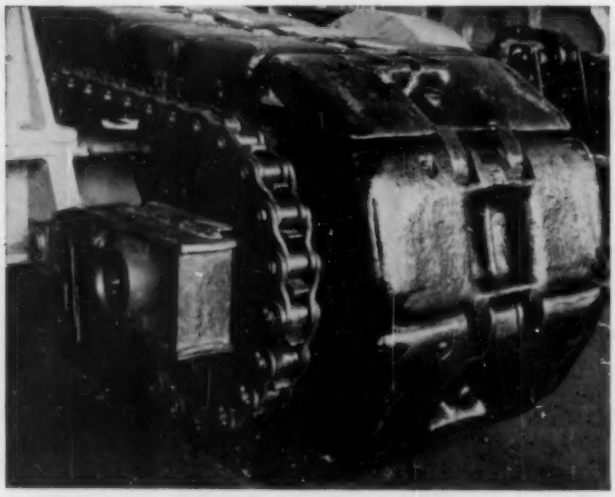
Progress Is Our Most Important Product

GENERAL ELECTRIC

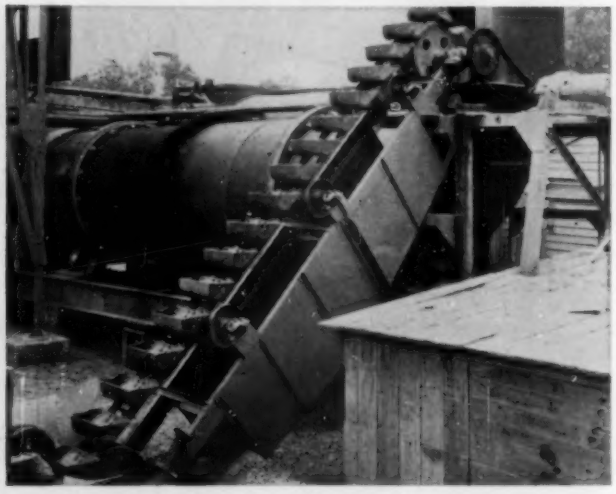
SMOOTH CONVEYING AND LONG LIFE were required in this conveyor carrying auto headlights through an oven. The CHAIN Belt Man had the right answer...Rex® Double Pitch Roller Chains with carrier rollers...low in cost but high in service . . . saves space and power costs.



CUTTING COST, SPACE AND WEIGHT resulted from the application of Rex Roller Chain on this bean separator by the CHAIN Belt Man. From a single power source, the chains drive a number of shafts insuring accurate timing, eliminating heavy gear trains and shafting.



TOUGH SERVICE such as the crawler drive on a power shovel is a natural for Rex Chabelco Steel Chains. These rugged chains with their built-in clearances between working parts operate effectively in conditions of dust, dirt and heavy shock loads . . . assures more years of service.



FOUR TIMES THE SERVICE resulted from the Chain Belt Man's chain recommendation on this bucket elevator. Rex Z-Metal Chains are going strong after 4 years' service in abrasive operating conditions. Ordinary cast chain used previously gave only one year service.

You Can Profit By Their Chain Experience

If you have a design problem involving chain drives or conveyors, why not profit by the experience of others? Consult your CHAIN Belt Field Sales Engineer. In case after case this experienced chain application engineer has solved problems of reducing costs . . . improving performance...saving space.

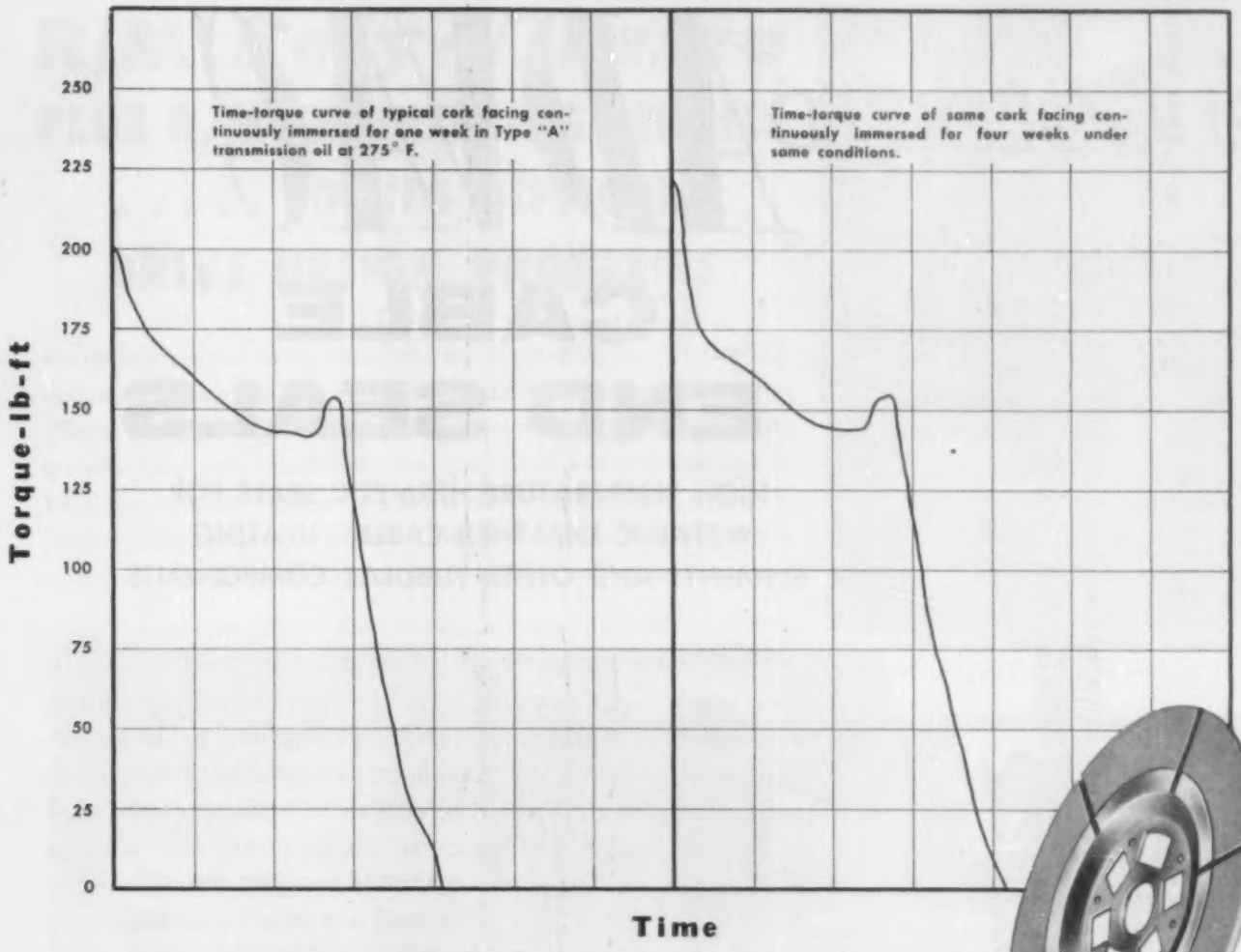
Your CHAIN Belt Man has a *complete* line of chains to choose from...can select and apply the one best choice for your needs. He knows no limitations in his selections...no handicaps of a limited line. He studies the operating conditions...the loads, speeds, mechanical requirements and your needs. And, then he arrives at the right answer.

Why not put his experience to work for you? Call your CHAIN Belt Man or write CHAIN Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wis.

AT YOUR SERVICE
to help you with chain drive and conveying applications
YOUR CHAIN Belt Man

CHAIN BELT COMPANY

District Sales Offices in all principal cities



CORK CLUTCH FACINGS:

High torque capacity at up to 300° F. ambient oil temperature

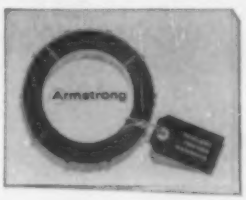
Many wet clutches faced with Armstrong resilient friction materials are run regularly at ambient temperatures in the 250° — 300° F. range, almost double the commonly accepted textbook standard. In fact, flash temperatures during engagement actually go much higher without damage to the facing.

As the charts above indicate, a cork facing can maintain its torque capacity even after weeks of constant exposure to hot oil. In this test, the torque was actually slightly higher at the end than at the beginning.

Actually, the upper limits of ambient temperature at which a cork facing will operate cannot be established accurately since many factors are involved. However, where heat is a problem, cork facings can be obtained which will give good service at any temperature which today's transmission oils will withstand.

This unusual performance stems from careful compounding of cork friction materials, based on painstaking research on the varying demands of different transmissions. As a result, millions of automobiles now have Armstrong-made cork facings in their automatic transmissions, and experience has shown that these facings will run for the life of the car.

For more information on cork-compound friction materials, send for a copy of "Armstrong Resilient Friction Materials." Write to Armstrong Cork Co., Industrial Division, 7209 Irvin St., Lancaster, Pennsylvania.



Armstrong FRICTION MATERIALS

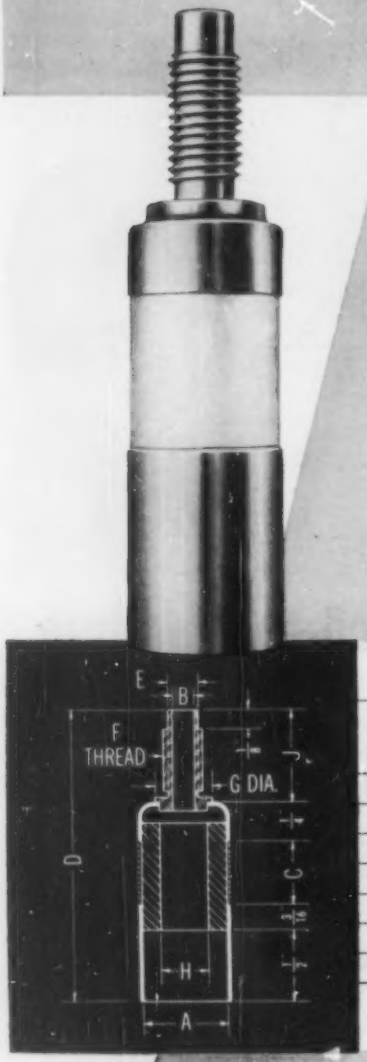
. . . used wherever performance counts

RUGGEDIZED *ADVAC*

CABLE END SEALS

- Provide Permanent Hermetic Sealing
- Terminal Assembly Complies with MIL-T-27 Requirements
- Withstand Temperatures to 1400°F and Pressures to 2000 P.S.I.

HIGH TEMPERATURE HERMETIC SEALS FOR METALLIC SHEATHED CABLES, HEATING ELEMENTS AND OTHER TUBULAR COMPONENTS



The ADVAC metallizing process applied to Hi-Alumina Ceramic produces super rugged hermetic seals. These standard cable end seals operate over extreme excursions of temperature, humidity, shock and vibration. The metal portions provide the ultimate in corrosion resistance and are easily bonded to associated equipment by brazing at temperatures up to 850°C.

For complete information on ADVAC End Seals or Seals for other applications, call or write today!

DIMENSIONS

TYPE	A	B	C	D	E	F	G	H	J	Operating Voltage*	Current Rating	Terminal Torque Rating†
250-ES	.250	.082	5/16	1-11/16	.125	8-32	1/4	1/8	7/16	1000	20 A.	15
320-ES	.320	.113	5/16	1-15/16	.148	10-32	1/4	5/32	11/16	1500	30 A.	20
330-ES	.330	.116	1/2	1-7/8	.148	10-32	1/4	5/32	7/16	1500	30 A.	20
375-ES	.375	.116	1/2	1-7/8	.148	10-32	1/4	3/16	7/16	2500	30 A.	20
450-ES	.450	.150	1/2	2-1/8	.203	¼-28	3/8	1/4	11/16	2500	60 A.	35
500-ES	.500	.150	1/2	2-1/8	.203	¼-28	3/8	1/4	11/16	2500	60 A.	35
625-ES	.625	.150	1/2	2-1/8	.203	¼-28	3/8	5/16	11/16	2500	60 A.	35

*40% R.H. – sea level – 60 cycles R.M.S. per MIL-T-27 Test Method.
†Rated maximum terminal rotational torque in inch lbs.

DIVISION OF GENERAL CERAMICS CORPORATION

ADVANCED VACUUM PRODUCTS • INC

118 Liberty Street, Stamford, Connecticut—Telephone: Davis 4-2148

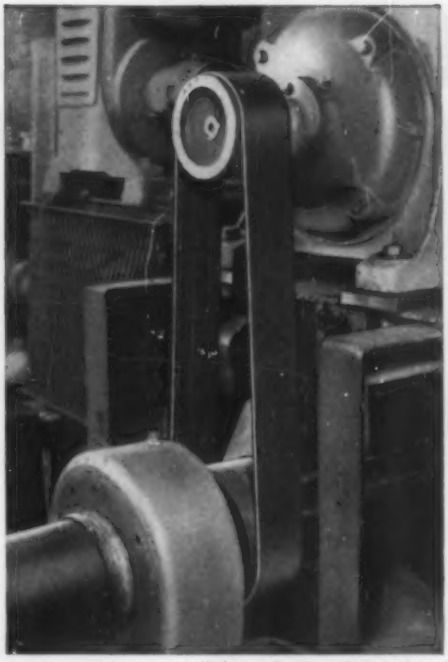
R/M *Poly-V*® *Drive*

PLUS R/M ENGINEERING SERVICE ..... SOLVES DIFFICULT DRIVE DESIGN PROBLEMS

Design engineers in many industries are discovering the outstanding design advantages of the R/M Poly-V Drive . . . and the service offered by the Raybestos-Manhattan engineers who developed this revolutionary and completely new concept of power transmission. Ideal for original equipment design applications, R/M's Poly-V Drive combines the high V-groove grip of V-belts with the strength and simplicity of flat belts in a *single* endless belt drive.

To help you solve difficult drive design problems with this exclusive, patented R/M development, Raybestos-Manhattan offers complete engineering data and service at no obligation. R/M engineers will gladly demonstrate advantages of R/M Poly-V Drive never before possible with ordinary V-belt drives. They are prepared to work personally with you and your staff . . . to study your drive design problems and make the proper recommendations.

Let R/M engineers show you why the R/M Poly-V Drive is proving the greatest advance in power transmission drive development since the multiple V-belt . . . for the improved design of both new and existing equipment. Write to Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J.



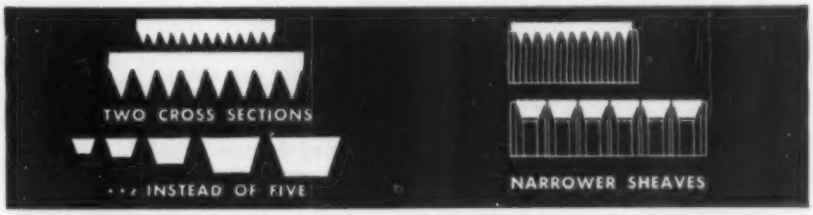
(Belmont Co. installation photo.)

R/M *Poly-V* in metal working

®Poly-V is a registered Raybestos-Manhattan trade mark.

NO MATCHING PROBLEMS — The Poly-V Belt is a single unit across full width of the sheave to give uniform pull, greater dependability and longer service because drive life is not limited to individual V-belt life.

CONSTANT PITCH DIAMETER — Poly-V Drive eliminates sinking of belt in sheave grooves . . . maintains constant pitch diameter and speed ratio at all loads for smoother, cooler drive operation . . . less wear on belt and sheaves.



ONLY TWO BELT CROSS SECTIONS — The entire field of heavy duty power transmission belt requirement is covered by two Poly-V Belt cross sections, instead of five multiple V-belt cross sections . . . simplifying drive inventories and increasing their interchangeability.

GREATER POWER CAPACITY WITH NARROWER SHEAVES — Because Poly-V Belt has higher horsepower capacity per inch of width, sheaves are narrower . . . you get more power in the same space as multiple V-belt drives, or equal power in less space.

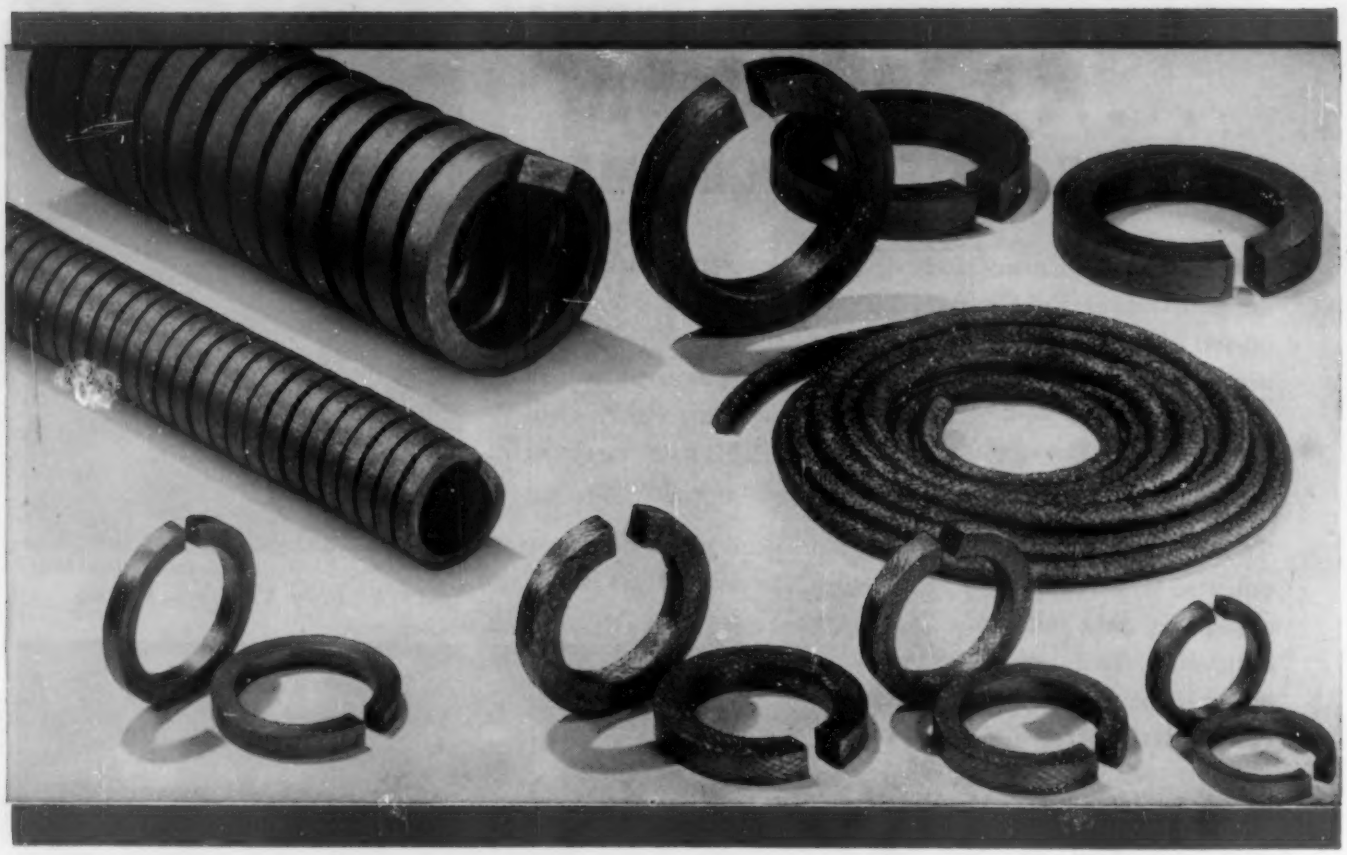
RM-537

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings • Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

CALL ON R/M ENGINEERING SERVICE



OUTSTANDING FOR PUMPS—R/M UNIVERSAL PACKINGS

The packings pictured above—R/M Universal Plastic Packings—are precisely engineered to the requirements of pumps and valve stems. Their performance under many different service conditions is uniformly outstanding. They can always be counted on to provide low friction and the resistance desired to materials handled, pressure and heat. The superlative ability of these packings to retain their lubrication is but one of the many secrets of their success—the lubricants are locked in so securely that even after wear sets in, the effectiveness of the bearing surface remains unchanged. R/M Universal Packings are particularly popular with maintenance men because they permit the practice of preventive rather than corrective maintenance.

The complete R/M line includes packings and gasket sheets for use against air, gas, water, steam, oil, chemicals, solvents, food products and hydraulic fluids. R/M also makes a wide variety of "TEFLON"* products and an unusual number of asbestos textiles. If you have problems involving any of these materials or products, feel free to call on R/M's specialized engineering service.

**DuPont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

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R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

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Fan Belts and Radiator Hose

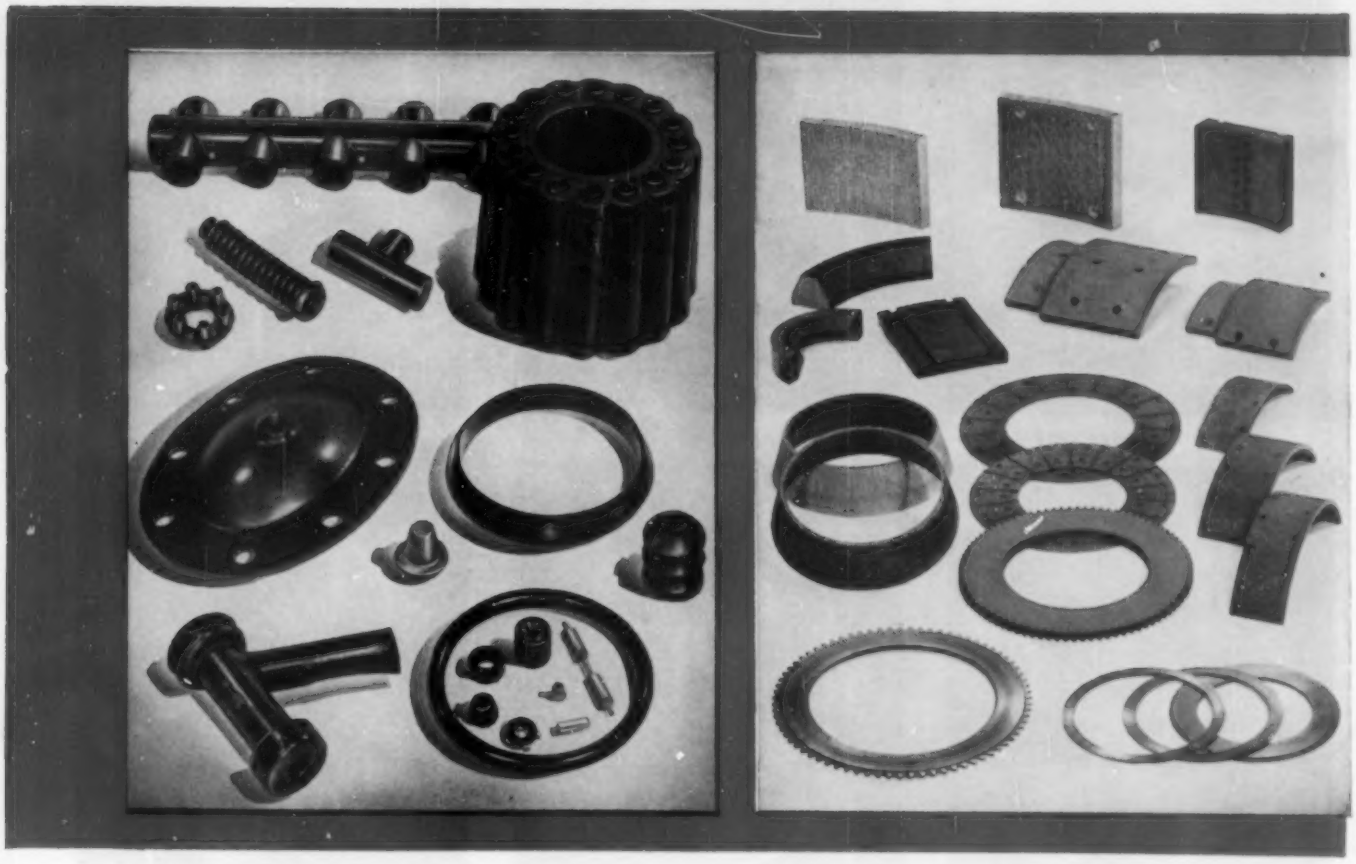
Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



MOLDED PARTS—Rubber • Silicone • Nylon

Molded parts of natural or oil-proof synthetic rubber, silicone or nylon are custom-engineered and mass produced by R/M for long, trouble-free performance under all conditions of use. R/M engineers, backed with over 60 years' molding experience, help you determine the right design and material for your application . . . to meet new requirements or to overcome troublesome conditions caused by parts now in use. You get the same dependable engineering help also in cut and extruded parts made to your special order. R/M's "Exclusive Features" book describes other R/M products . . . rubber hose, conveyor and transmission belts, V-belts. Let R/M specialists work with you.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

FRICTION MATERIALS

Unlike other manufacturers, R/M works with *all* kinds of friction materials, from asbestos to sintered metals. This means that when you consult an R/M engineer you can be sure of completely unbiased advice on which materials are best for your application.

Raybestos-Manhattan has been the world's largest maker of friction materials for over 50 years. Whatever your brake or clutch requirements, count on R/M experience, and R/M manufacturing and testing facilities, for a friction material exactly suited to your needs.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

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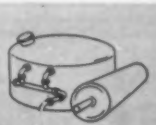
Conveyor Belts


Rubber Lined and Covered Equipment

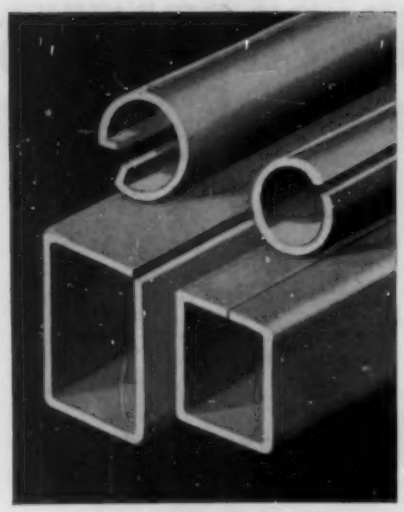
Sintered Metal Friction Elements

Asbestos Textiles

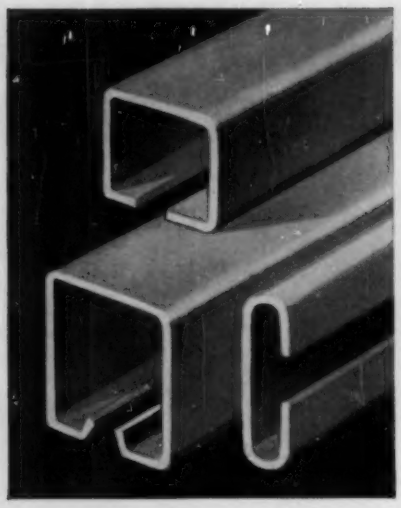
Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

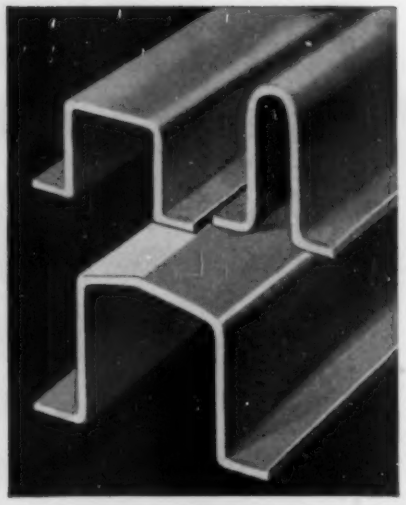
R/M



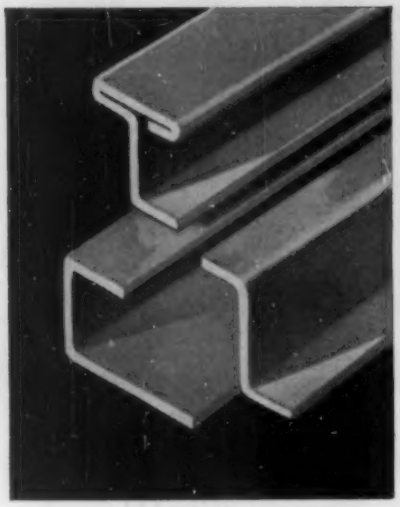
TUBULAR SECTIONS



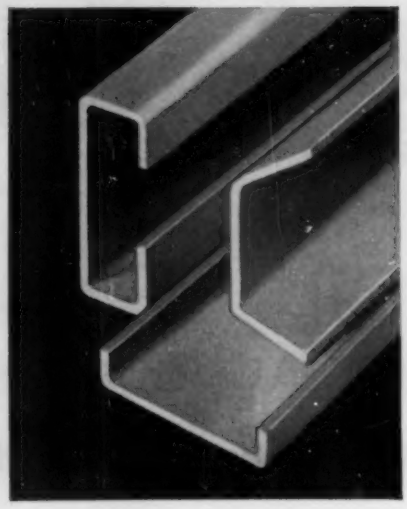
TRACK SECTIONS



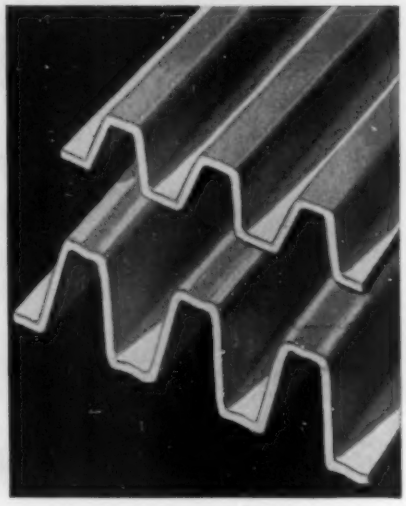
HAT SECTIONS



TEES AND ANGLES



CHANNEL SECTIONS



SPECIAL SECTIONS

Each of these Shapes saved time and money for some manufacturer

Each one of the Bethlehem Cold-Formed Shapes we show here has saved some manufacturer both shop time and money. The sections shown were chosen from many hundreds to give you an idea of the range and versatility of Bethlehem Cold-Formed Shapes. There is almost no limit to their application in a wide variety of industries, including agriculture, transportation, manufacturing of all types, and materials-handling.

Bethlehem Cold-Formed Shapes save time because they are made to the customer's dimensions, to fit a particular job, with no need for cutting, bending or punching. Sections made from cold-rolled, or pickled and oiled steel are free from scale, ready for painting or welding without further preparation.

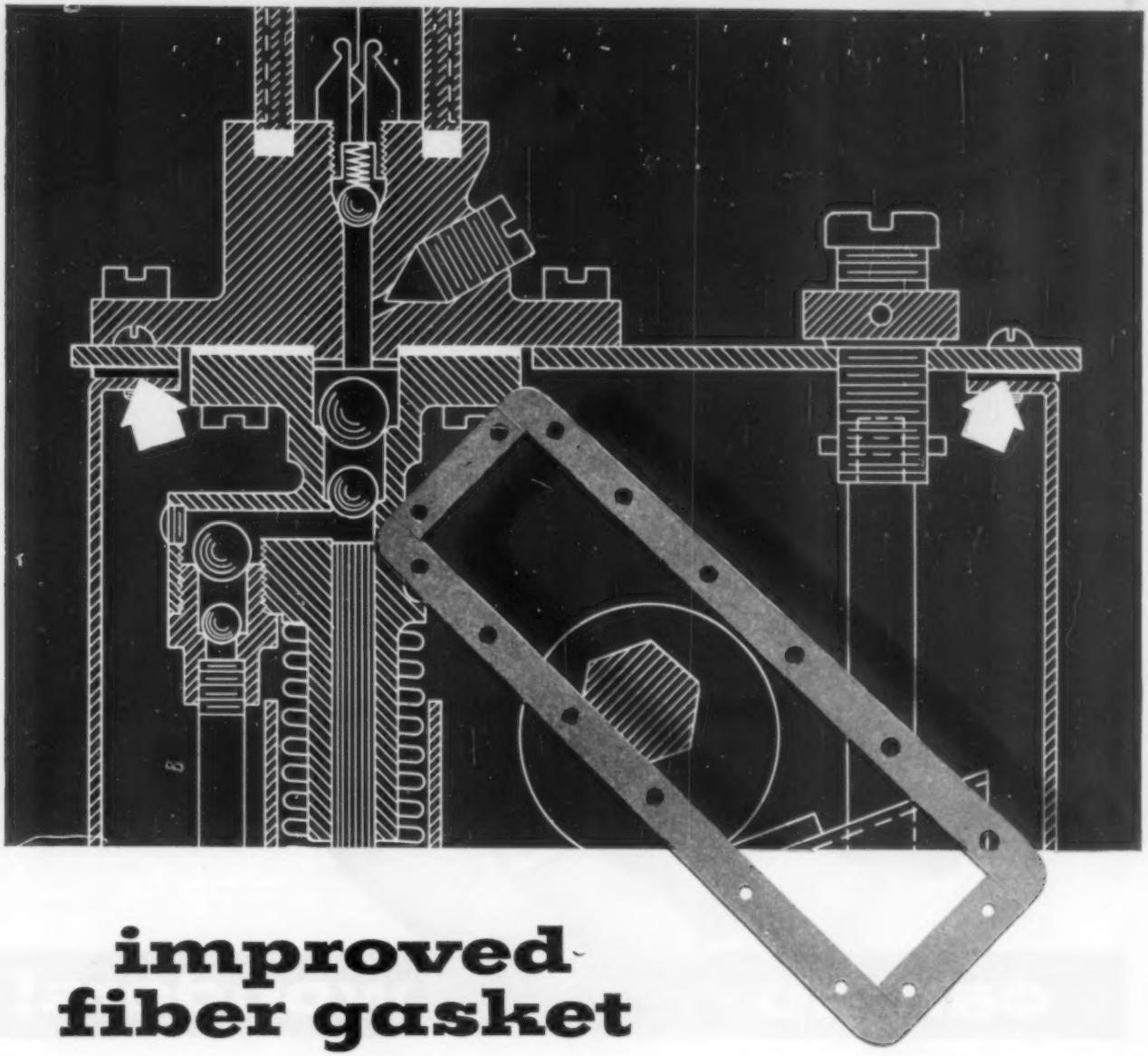
Bethlehem Cold-Formed Shapes save money because in many cases a lighter section can be used in place of heavier, hot-rolled material. There's no need to maintain large plant inventories, for Bethlehem will make and ship Cold-Formed sections as they are needed. No problem of scrap disposal, either.

Chances are that one of the shapes you see here—or a modification of it—could be adapted to your own product. Our engineers will be glad to study your needs and give you suggestions. We make a full range of shapes, in any gage from 5 to 24, of sheet, strip or plate steel, in almost any length. Your inquiry addressed to the nearest Bethlehem sales office will receive prompt attention.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL



improved fiber gasket

won't shrink, costs less, reduces fabricating time

A manufacturer was using four strips of gasket material which he butted together to seal the oil tanks and covers of force feed lubricators.

But the material was fragile, often had "lace" or pinholes, and was subject to shrinkage. Also, the strips had to be cut from sheet material . . . and this didn't produce pieces long enough to fit the largest tanks without splicing.

Problems were ended and costs lowered, however, by using Armstrong CN-705 Accopac® in ribbon form. This fiber gasket material is made by a beater saturation process that locks the fiber and cork in a latex binder. The lubricator manufacturer found it to be a uniformly strong and flexible material, free of porosity. Accopac did not shrink or leak.

Gasket fabrication was simplified, too. An operator simply cut the Accopac ribbon to length, cemented it into place, and punched the bolt holes.

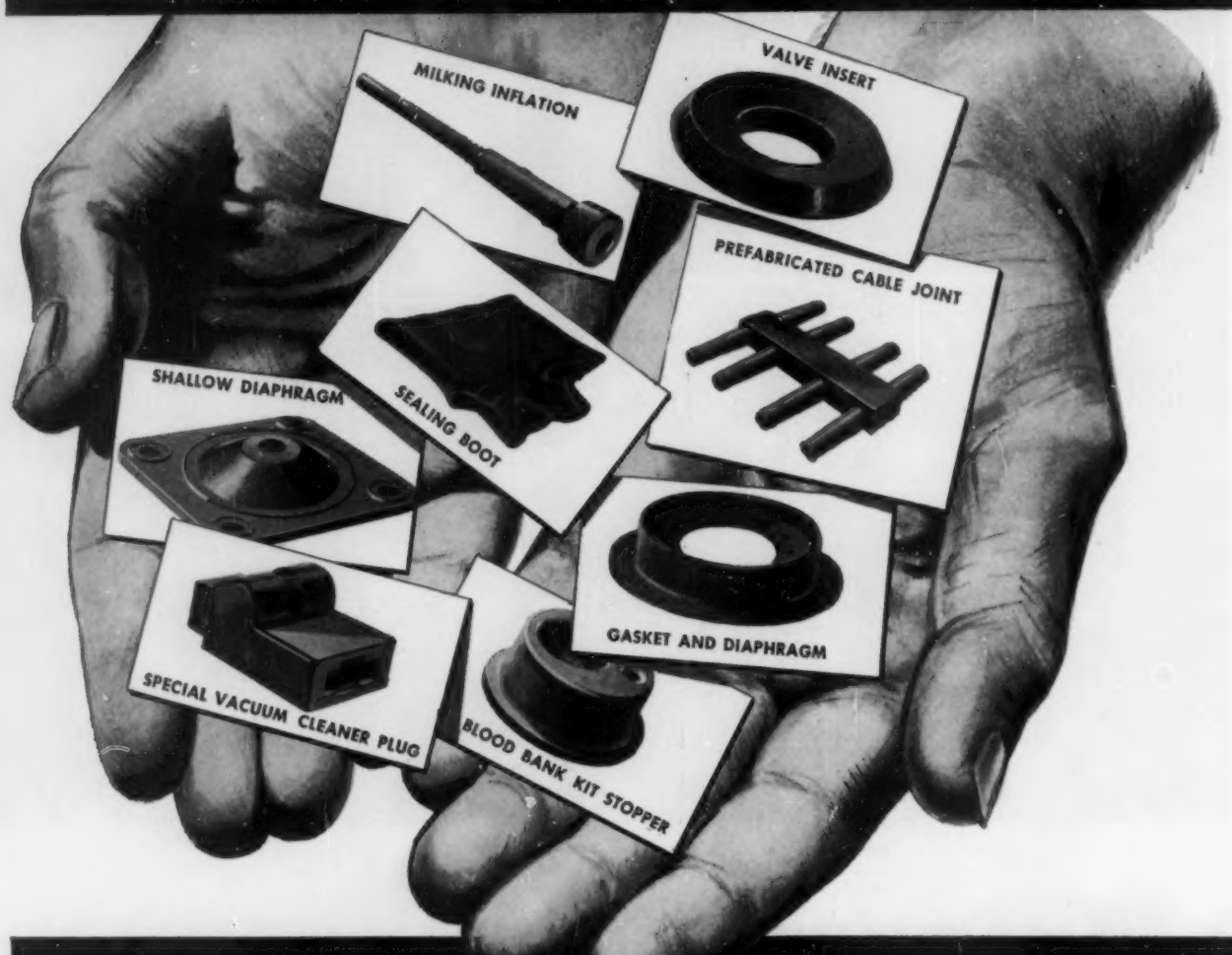
Perhaps Accopac in sheets, rolls, ribbon, or die-cut parts can solve your gasket problem, too. Write today for samples for your own evaluation.

FREE 24-PAGE GASKET MANUAL— Look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write for your own copy to Armstrong Cork Company, Industrial Division, 7009 Irvin Street, Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket cutter.**

Armstrong Accopac

. . . used wherever performance counts

Rubber in the right hands



can do wonders!

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★ **A maker of milking inflations picked "U. S." molded rubber—because of its flexing characteristics (up to 400 hours in a flexing cycle test—where normal requirement is a 100 hour test.)**

★ **A utility company selected "U. S." molded rubber cable joints because "U. S." could fabricate an entirely *uniform* wall thickness in an extremely complex design. The high dielectric resistant compound provides top safety.**

★ **A lawn mower manufacturer cut labor time of treading from 7 minutes to 49 seconds—just by specifying "U. S." molded-drive roller rubbers.**

These are only a few of the hundreds of applications wherein U. S. Rubber's molded rubber works wonders. In the hands of "U. S." technicians, molded rubber becomes a basic material that will *do jobs no other material can do.* "U. S." research stockpiles, nationwide facilities and laboratories are joined with "U. S." experts in tackling any molded rubber goods problem quickly—and from every angle. Let "U. S." show you what it can do with molded rubber.

Get in touch with United States Rubber Company's Molding and Extrusions Department through address below.

US RUBBER

"U. S." Research perfects it..."U. S." Production builds it... U. S. Industry depends on it.

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MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

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Point of Honor

From the collection of Lewis Winant, New Jersey Arms Collectors Club. Maker: Johann Kuchenreuter, Regensburg, Germany, 1740-1757. An 11-by-14 inch print of this illustration with bearings and lettering omitted is available on request on company letterhead.

In today's business dealings (as in yesterday's "affairs of honor") both parties are protected by an intangible factor known as INTEGRITY—a figurative handsake between producer and consumer. Today, this point of honor assures you that the product you buy is exactly as represented. When you write COMPO Oil-Retaining Porous Bronze Bearings into your specifications you find that it is a point of honor with Bound Brook, as a reliable manufacturer, to provide you with the best powder metallurgy bearings that can be produced.

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS & PARTS

Quick-Opening Fasteners: Screw Type or 1/4 Turn?

Know the features of each before you specify.

M. R. TUOZZO

The selection of a quick-operating door fastener usually involves a choice between two basic designs; the quick-acting screw fastener and the ¼ turn fastener. Both are relatively inexpensive. Each has advantages that make it the logical choice for certain applications.

THE SCREW FASTENER is a rugged, square threaded screw assembly engaging in a special heavy stamped nut. The nut is clipped, riveted, or welded to the door frame. A special washer behind the thread captivates the screw in an oversize hole in the door.

Because of its exceptional "float," it is installed without precision measurements and will always line up with ease. Where a variation in material thickness may occur or a gasket must be compressed, the screw fastener is preferred, since a single grip length can be used throughout. Under most conditions it will completely disengage in two to four turns. It offers excellent resistance to vibration and forms a solid joint with no "give."

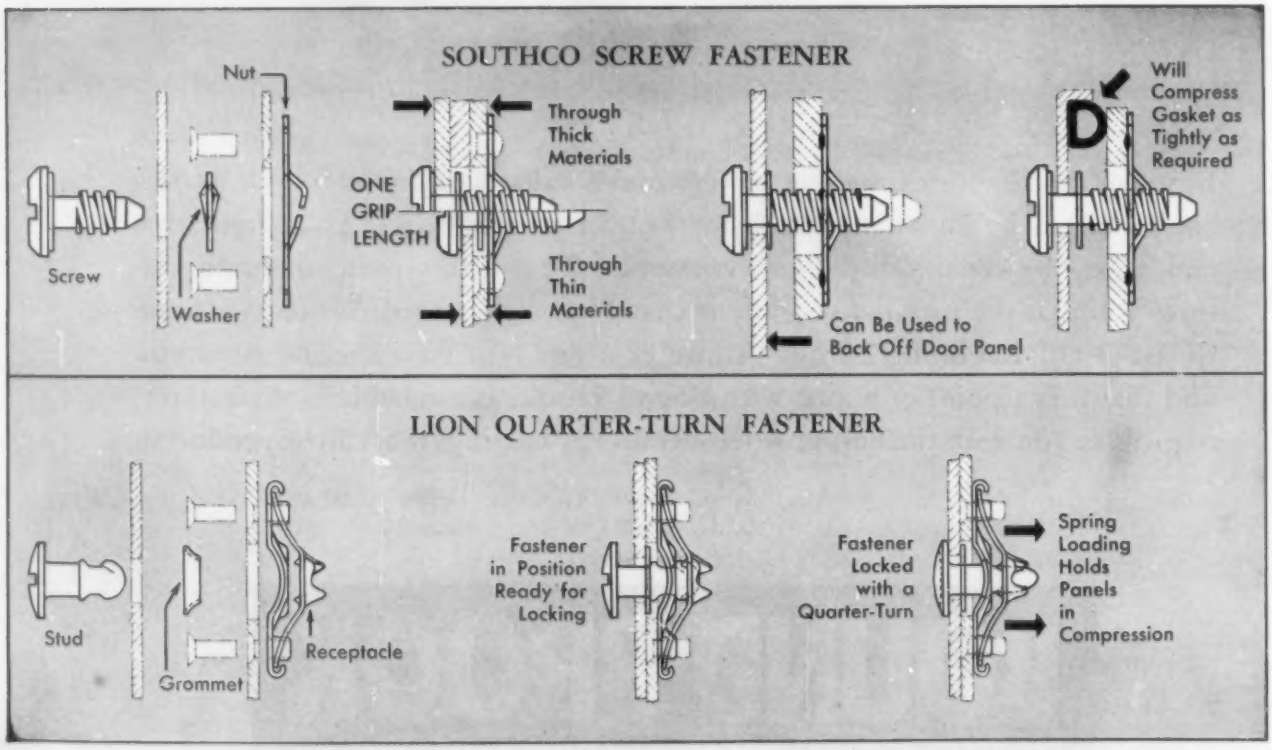
The screw fastener can be backed all the way out of the door frame without moving the door. If required, it can be installed so as to jack the door open as it is unscrewed.

THE QUARTER-TURN FASTENER is usually selected for application on aircraft (under Army-Navy-Air Force specification MIL-F-5591A) where instantaneous removal of fastened parts is required. As the name implies, it is quickly locked or unlocked by a fractional turn.

Its strength characteristics also are very high when the stud is formed from a single piece and no thin springs, wires, or cross pins exist in the assembly. The stud is retained in the door panel by a metal grommet, and engages in a full floating spring-loaded receptacle, riveted or welded to the door frame.

Where the thickness of door and frame are fairly constant through an entire production run, the quarter-turn fastener is a wise choice. Its design affords maximum speed in fastening, and excellent vibration resistance.

COMPARISON OF STANDARD QUICK-OPENING FASTENERS



SOUTHCO Division, South Chester Corporation, 236 Industrial Hwy., Lester, Pa.

for tubing
that can take it—
and can take
any shape

Remember
GM STEEL TUBING
By Rochester Products

GM STEEL TUBING BY ROCHESTER PRODUCTS, DIVISION OF GENERAL MOTORS, ROCHESTER, N.Y.

Are You Aware of the Exciting Opportunities for Product Improvement that Exist Now?

Today, industry is forging ahead in the development of products little dreamed of only a few short years ago.

Instrumentation . . . miniaturization . . . more automatic production . . . all are demanding parts and components with new operating advantages. And High Nickel Alloys are playing an important part in meeting the needs. Are *you* aware of the opportunities High Nickel Alloys offer? For example, do you know you can . . .

. . . Design smaller, lighter weight units through the use of "extremely sensitive" alloys that respond to very weak electrical currents?

. . . Assure precision product performance with the help of an alloy that exhibits infinitesimal size change through temperature ranges up to 400°F?

. . . Compensate a given magnetic field for temperature changes to insure consistently accurate product performance?

And the list goes on . . . an exciting list of properties that can lead to rewarding fields of new and improved products!

Getting High Nickel Alloys to do special jobs for you . . . making them behave in the way *you want them to behave* . . . is an opportunity we welcome. By making a team of your engineering experience and Carpenter's ability to produce closely controlled High Nickel Alloys with predetermined behavior, you often take an immediate step to product improvement. To help you in this job, Carpenter manufactures an unusually complete line of High Nickel Alloys . . . Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys. These are available in the largest variety of forms including strip, wire, bars, tubing, forging billets, etc. Ask for detailed engineering and application information. A note on your company letterhead is all that's necessary.

Carpenter STEEL — **High Nickel Alloys**

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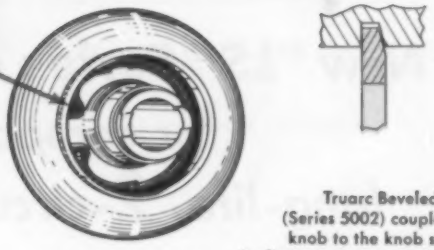
The Carpenter Steel Company, 117 W. Bern St., Reading, Penna.
Export Department: The Carpenter Steel Co., Port Washington, N .Y.—"Carsteelco"

Waldes Truarc Retaining Rings Eliminate Machining— Provide Stronger Assembly, Greater Accuracy

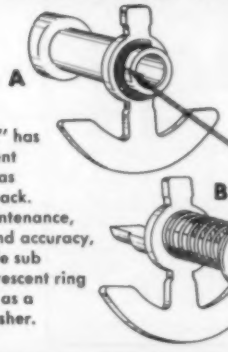
The American Hardware Corp., New Britain, Conn., uses 4 different types of Waldes Truarc Retaining Rings in the original design of these famous Corbin and Russwin Heavy Duty Cylindrical Locks. Truarc rings improve product performance, eliminate rejects, and cut labor costs.

Knob Sub Assembly



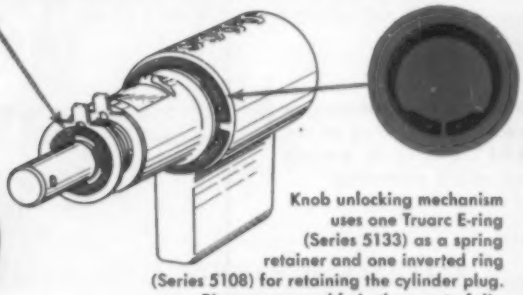
Truarc Beveled Ring (Series 5002) couples the knob to the knob shank. It eliminates two tapped holes and two screws, provides stronger assembly and greater accuracy. Beveled ring takes up end play rigidly.

Spindle Sub Assembly



Spindle sub assembly "A" has two Waldes Truarc crescent rings (Series 5103) used as locating flanges for rollback. This saves labor and maintenance, improves performance and accuracy, eliminates rejects. Spindle sub assembly "B" uses one crescent ring as a spring retainer and as a locating shoulder for washer.

Cylinder Sub Assembly



Knob unlocking mechanism uses one Truarc E-ring (Series 5133) as a spring retainer and one inverted ring (Series 5108) for retaining the cylinder plug. Rings are re-usable in the event of disassembly for maintenance. Rejects are eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

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WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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PN097

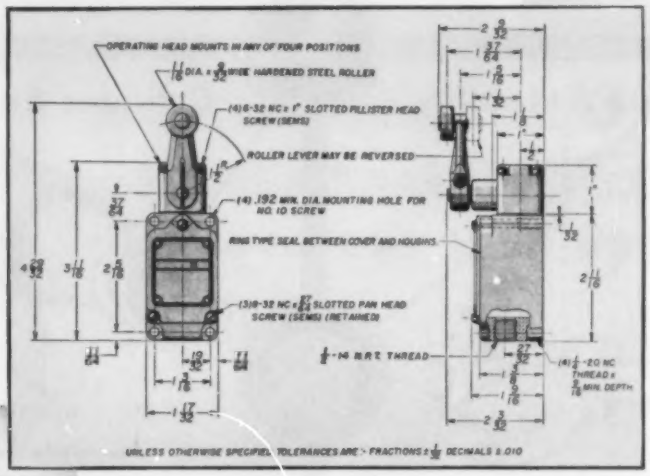
WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

Introducing a New Series

New "LS" Series meets need for compact, precise, long-life, 2-circuit switches

Precision two-circuit switching unit is enclosed in a rugged aluminum housing.

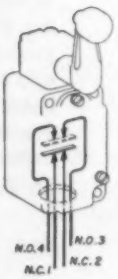

OPERATING HEAD MOUNTS IN ANY OF FOUR POSITIONS
ROLLER LEVER MAY BE REVERSED
RING TYPE SEAL BETWEEN COVER AND HOUSING
UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE: FRACTIONS ± DECIMALS ± .010

Dimensional drawing shows compact size of the "1LS1" switch to permit small space mounting.

"7LS1"

Cover plate with "7LS1" switch for mounting into recess in machine.

The new MICRO SWITCH "**1LS1**" Switch is a small two-circuit limit switch. Its sealed construction, reliability, long life and features of adjustability suit it to all types of industrial applications.

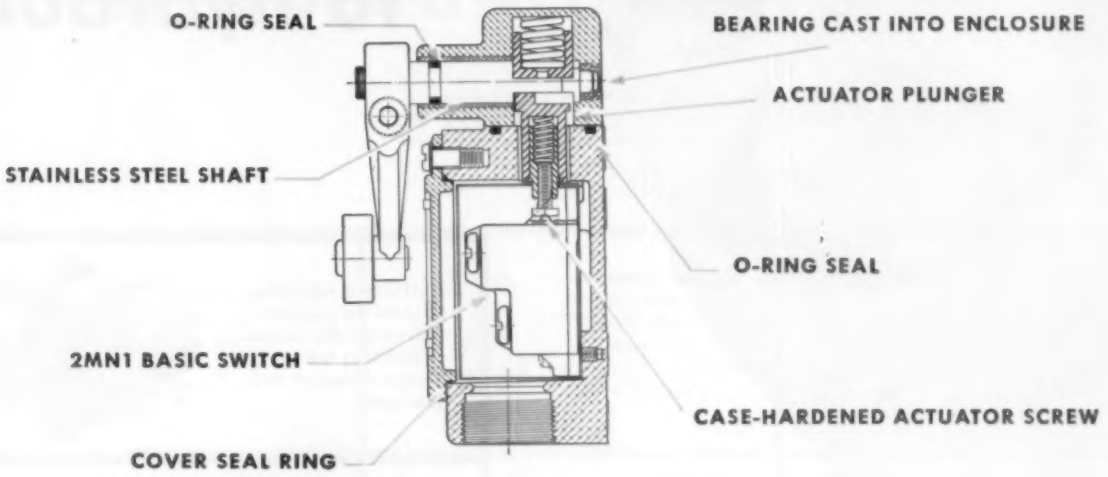


Also available is the MICRO SWITCH "**7LS1**" Switch. This is a flush-mounted design which may be recessed into a cavity in the machine. Operating characteristics of both switches are identical.

Contact arrangement of the basic switching unit is two-circuit, double-break. The electrical rating is: 10 amperes, 120, 240 or 480 volts a-c; ½ H.P., 115 volts a-c; 1 H.P., 230 volts a-c. Pilot duty rating is: 600 volts a-c, max.; .2 amperes, 115 volts d-c; .1 ampere, 230 volts d-c; .04 amperes, 550 volts d-c.

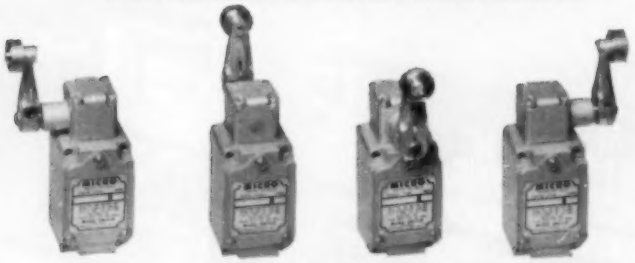
# of Precision Limit Switches

SEALS PROVIDE MAXIMUM PROTECTION



Sealing is provided by use of O-ring seals on the actuator shaft between the actuator head and the housing. A synthetic rubber ring seal is also provided for the cover. These seals provide maximum protection against entrance of dust, oil and other liquids. The switch meets NEMA specifications for an oil-tight pilot device.

ADJUSTABLE HEAD ASSEMBLY



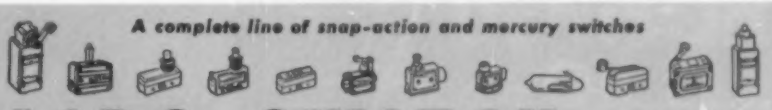
The "1LS1" switch can be easily mounted in almost any location. The actuator head may be removed in the field and rotated to any of four positions. Actuation of the switch is possible from any of the four quadrants to meet the requirements of the specific application.

FIELD ADJUSTABLE ACTUATOR

The roller arm actuator is field adjustable through 360 degrees, positively locking in any position. Actuators are assembled to operate in either direction. They can also be converted to operate in one direction only, clockwise or counterclockwise.

MICRO SWITCH field engineering is available to bring you more complete information on these new "LS" switches and help you select the exact switch to meet your switch requirements. Call the nearest MICRO SWITCH branch. Save time and money.

A complete line of snap-action and mercury switches



MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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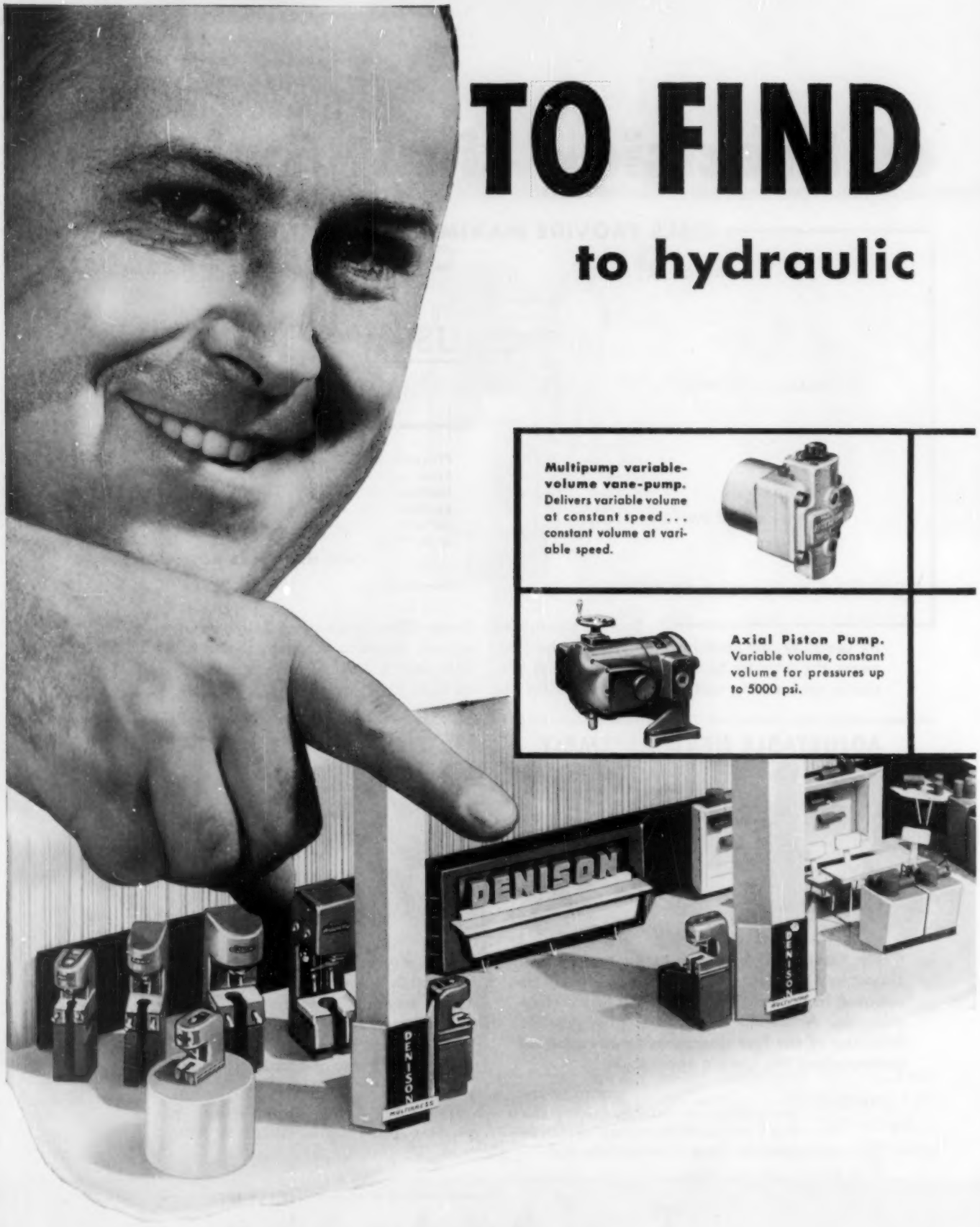
H HONEYWELL

TO FIND
to hydraulic

Multipump variable-volume vane-pump. Delivers variable volume at constant speed . . . constant volume at variable speed.

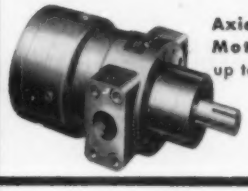
Axial Piston Pump. Variable volume, constant volume for pressures up to 5000 psi.



THE ANSWERS

power–speed–control

VISIT US AT **BOOTH 819**

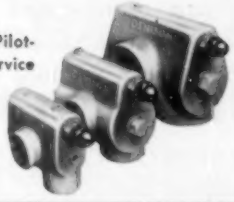


Axial Piston Fluid Motor for service up to 5000 psi.

Pressure Controls Relief, sequence, unloading, pressure reducing valves. Pilot-operated for circuits up to 5000 psi.

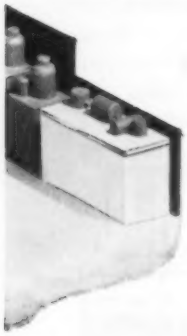
Multi-range Flow Control for full range regulation on variable speed circuits. For service up to 3000 psi.

Relief Valve. Pilot-operated for service up to 2000 psi.



Directional Control. 4-way pilot-operated, solenoid-controlled for service up to 3000 psi.

Pump-Motor. Vane-type, continuous duty to 2000 psi with bi-directional rotation.



WHAT'S YOUR PROBLEM?

Let Denison help you solve it . . . at Booth 819.

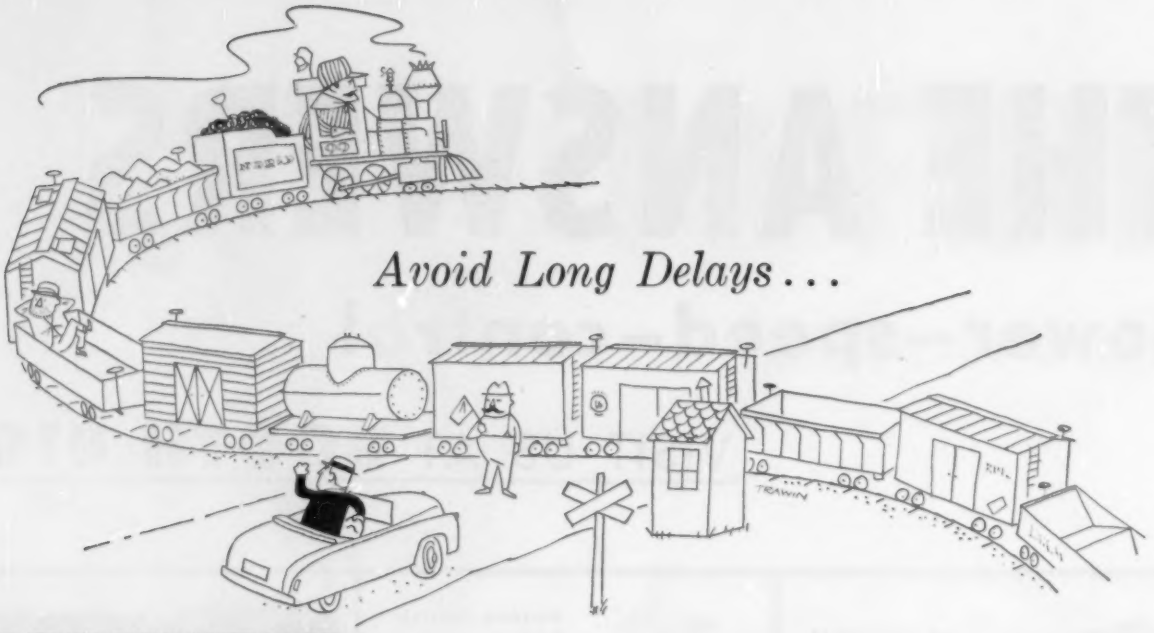
As a machine tool builder, Denison is privileged to demonstrate and display its entire line of precision hydraulic pumps, hydraulic motors and controls.

As a designer of machine tools and automatic machinery, you obtain data on Denison's latest developments in hydraulics . . . at the same time you witness a full line of Multipress in action.

While you are at our booth, one of Denison's hydraulic engineers will gladly suggest how to simplify your circuits, build greater dependability into your hydraulics . . . and cut costs of hydraulic equipment.

THE DENISON ENGINEERING COMPANY
1194 DUBLIN ROAD — COLUMBUS 16, OHIO
Subsidiary of American Brake Shoe Company

DENISON HydrOILics



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TORRINGTON *delivers small precision parts promptly*

"On time" shipments of Torrington small precision metal parts will keep your production lines moving.

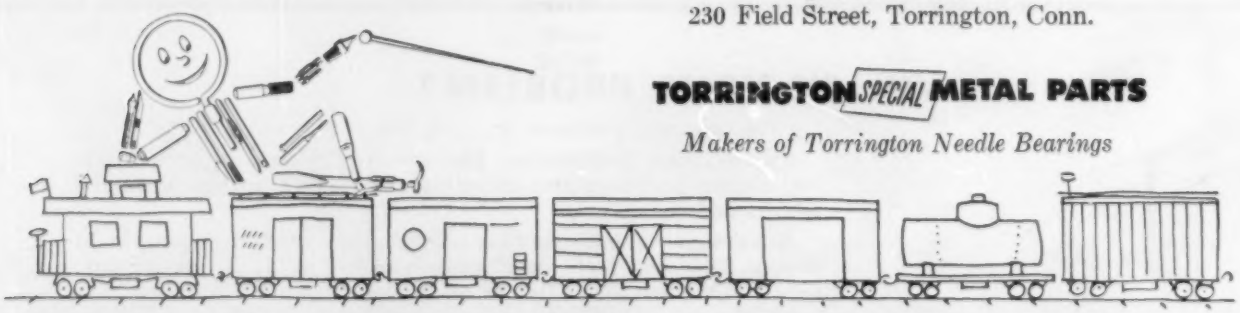
Special automatic machinery of our own design, plus almost 90 years of precision metalworking experience, enables us to produce your small precision parts *faster, better and for less* than you can make them yourself. And we follow your specifications *exactly* on tolerances, temper, hardness and finish.

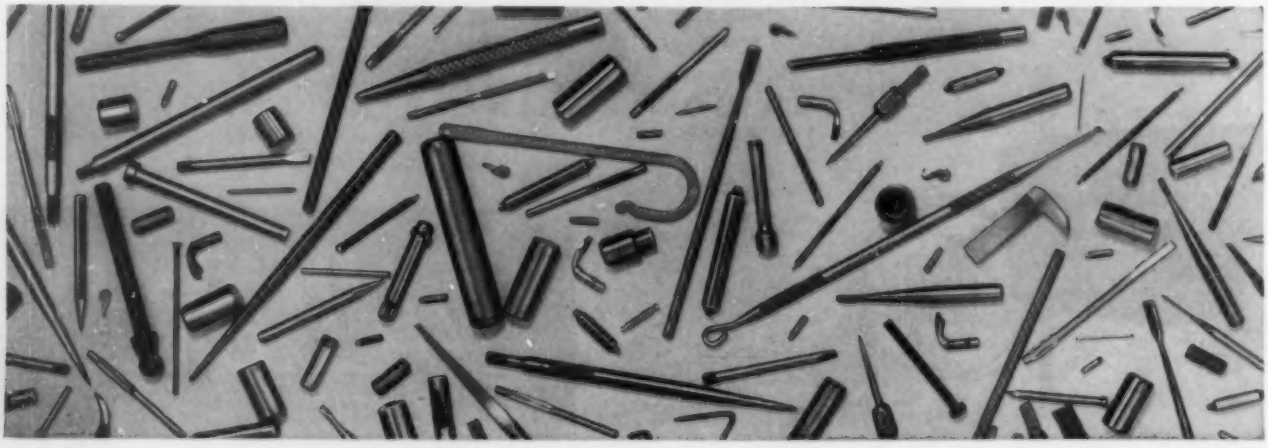
Send a sample part or blueprint for our quotation. Our Condensed Catalog illustrates many of the parts we can produce for less. Ask for it.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings





Graph-Mo® steel die makes this "impossible" draw without galling or scoring

MANUFACTURERS Service Company in Cleveland was faced with a tough problem of making a die for a dryer fan housing 3⅞" deep. The scroll shape made it an all but impossible draw for ordinary die steels—they'd pick up and gall. Looking for an answer, they tried Graph-Mo®—one of four graphitic tool steels developed by the Timken Company. Result: good clean parts, no scuffing, no galling, no scoring.

Graph-Mo tool steel can handle jobs like this because of its unique composition. It contains free graphite, one of the best natural lubricants. This graphite gives Graph-Mo outstanding anti-friction properties and prevents scuffing and galling even in such difficult draws as this one.

Graph-Mo has a second great advantage over conventional tool steels: It outwears them on an average of three to one. Along with the graphite, Graph-Mo contains millions of tiny particles of diamond-hard carbides, one of the hardest-wearing substances known.

Despite its superior wear resistance, Graph-Mo machines about 30% easier than conventional tool steels. And it responds uniformly to heat treatment, thus requiring a minimum of grinding on the hardened dies.

Graph-Mo is one of four graphitic tool steels developed by the Timken Company. Would you like more information about their uses in dies, punches, gages and machine parts? Write for the new Timken Graphitic Steel Data Book just out. The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Engineered RELAYS for Engineered Products

"Your best source for relays" is Potter & Brumfield, because of an enviable reputation earned through a *quarter century* of relay specialization.

Millions of relays of *all styles* and *sizes* designed and manufactured to meet customer specification.

From small sub-miniature, precision, sensitive relays to heavy duty power types, each fulfilling an exacting requirement.

Enclosed, hermetically sealed or open relay structures to meet demands of various environmental conditions.

Priced competitively at all quality levels. Samples available for immediate shipment. Send your specification for recommendations and quotations.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

discriminating

~~most~~ engineers choose Potter & Brumfield

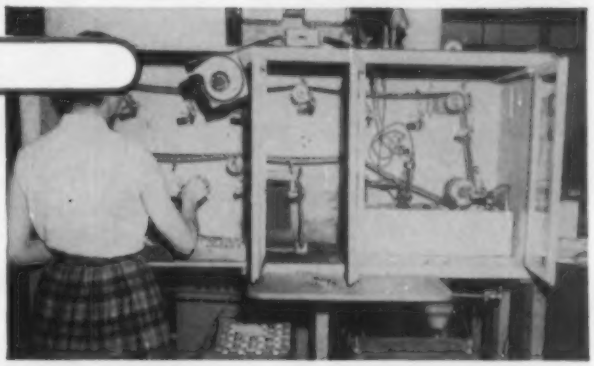
100% HI-POT TEST

Some sealed relays have as many as ninety possible voltage breakdown points. This tester, developed by Potter & Brumfield, checks every breakdown point automatically with extra high voltage and for the necessary time interval.

ULTRASONIC CLEANING

Another Potter & Brumfield development, the use of Ultrasonic cleaning in relay manufacture.

Potter & Brumfield sealed relays are tops because they are thoroughly cleaned of all dirt, solder flux and other contaminants by silent sound.



MICROSCOPIC INSPECTION AND ASSEMBLY

The small watch size parts of many Potter & Brumfield relays are inspected and assembled under ten power magnification.

Thus assuring the close tolerances necessary for long life and dependable operation of miniature and sub-miniature relays.

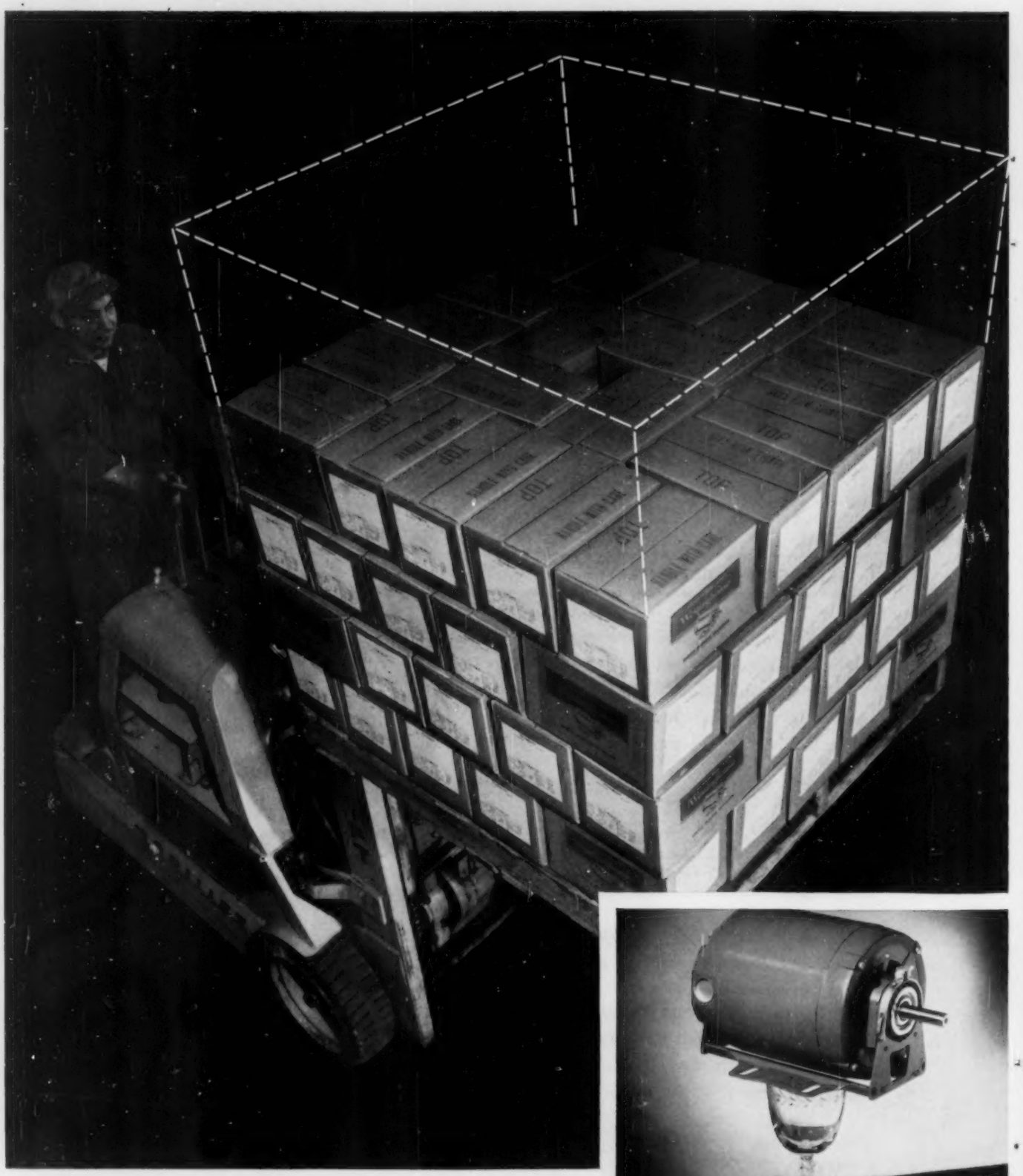
For quick delivery, over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Another AMF Product

P&B Relays

POTTER & BRUMFIELD MFG. CO., INC.
Princeton, Indiana

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS



Fact 2 . . . weight savings up to 50% allow smaller, lighter motor mounts and housings . . . reduce your material and shipping costs.

New Westinghouse Motor Saves Up to 40% Storage Space

. . . one important FACT about the new Westinghouse 48-frame fhp motor

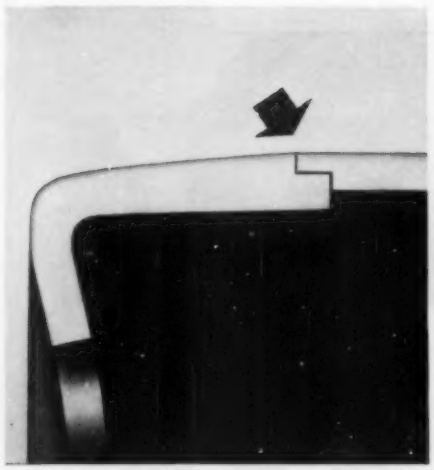
More compact in design, the new Westinghouse 48-frame motor offers spacesavings of 25% to 40% over comparable motor ratings. Yet, it does the work of the much larger 56 frame.

Being smaller in size, this new motor takes up less room in your product. It requires less room to stock. And it's easier to handle on assembly lines, faster to install. Mounting-wise, it offers complete versatility. Don't expect all these benefits in any other motor.

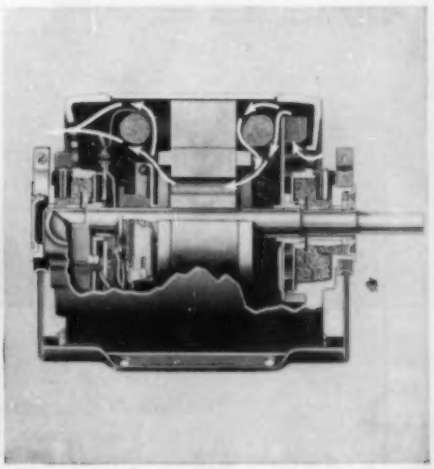
The Man With The Facts, your Westinghouse sales engineer, has all the information about this new, fhp line. Contact him today. Or write for DB-2801. It contains complete technical data. Westinghouse Electric Corporation, Small Motor Division, Lima, O.

J-03021

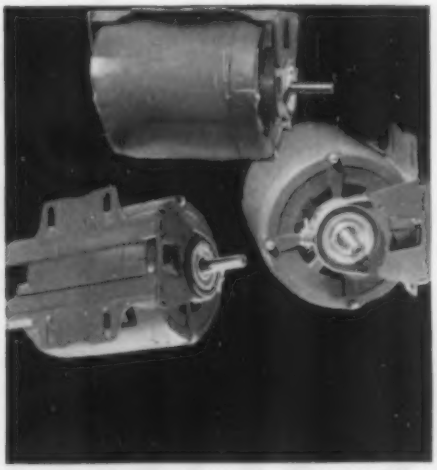
YOU CAN BE SURE...IF IT'S Westinghouse



Fact 3 . . . heavy frame with machined fit for end bracket assures positive alignment and permits welded-on base for truly rigid mounting.



Fact 4 . . . straight-through ventilation system of this new motor assures cooler operation for longer running periods, even at peak loads.



Fact 5 . . . no "swiss-cheese" vent holes in the solid frame to restrict mounting angles or allow liquids or dirt to damage windings.

FAST SERVICE IS CHASE'S SPECIALTY FOR STAINLESS STEEL!

Twenty-five warehouses, four sales offices, stand ready to supply you the type, shape, size and quantity of stainless steel you need. You get the same kind of dependable service that has made Chase the nation's *headquarters* for brass and copper. Call Chase *today* for stainless steel!

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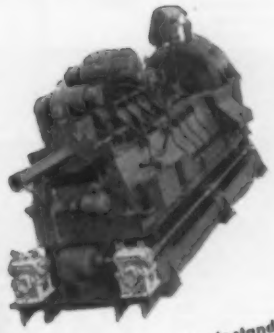
Boston	Dallas	Indianapolis	Minneapolis	Pittsburgh	Seattle
Charlotte†	Denver	Kansas City, Mo.	Newark	Providence	Waterbury



Cleveland worm gearing is standard on these fully-automatic machines which thread oil field pipe to rigid A.P.I. specifications, ranging from 1¼" to 13⅜" O.D. In addition to worm gearing inside the machine, note two Cleveland Worm Gear Speed Reducers in foreground.

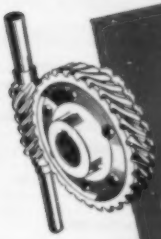
On job 18 years, CLEVELAND drive is good as new

AFTER 18 years of continuous service in a well-known pipe mill in Pennsylvania, a Stamets pipe threading machine had its first major overhaul. When the Cleveland worm gearing was removed from the machine it looked almost like new, showed only slight traces of wear. This unretouched photograph reveals the splendid condition of both the worm and gear. In fact, the gearing is in such fine shape that it was put right back in the machine—probably good for another 18 years of strenuous pipe threading.

This example is one of thousands of Cleveland worm gear drives, many made 25 and even 30 years ago that are still in service today. They serve in every phase of American industry, drive every type of mechanical equipment where a powerful, trouble-free, right-angle drive is wanted.

For full presentation of the many types and sizes of Cleveland worm-gear drives available, write for Catalog 400. The Cleveland Worm & Gear Co., 3279 E. 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: Peacock Brothers Limited.



CLEVELAND
Worm Gear
Speed Reducers

Resistance Ratings
A = Good
F = Fair
C = Depends on conditions
X = Unsuitable

CAUTION: Do not use table without reading text.

	Asbestos			All Rubber					Misc.	
	Compressed sheet	Woven rubber	Woven neoprene	GR-S	Neoprene	Buna-N	Butyl	Natural	Plant-fiber sheet	Teflon
Acetic acid, crude	C	C	A	C	F	F	F	C	F	A
pure	C	C	A	C	F	F	F	C	F	A
vapors	C	C	A	C	F	F	F	C	F	A
150 p.s.i., 400 deg. F.	F	C	–	X	F	F	X	X	X	A
Acetic anhydride	–	C	A	–	–	–	–	–	–	A
Acetone	A	A	X	A	C	X	A	F	C	A
Acetylene	A	A	–	A	C	A	A	A	C	A
Air	A	A	A	A	A	A	A	A	A	A
Aluminum chloride	A	A	A	A	A	A	A	–	A	A
Aluminum fluoride	–	A	–	–	–	–	–	–	–	A
Aluminum sulphate	–	A	A	A	A	A	A	–	A	A
Alums	A	A	C	A	A	A	A	–	A	A
Ammonia gas, cold	A	A	A	A	A	A	A	A	C	A
hot	A	A	–	C	A	C	C	C	C	A
Ammonium chloride	A	C	A	–	A	–	A	A	X	A
Ammonium hydroxide	A	A	A	C	C	C	A	C	F	A
Ammonium nitrate	–	C	F	A	A	A	A	A	–	A
Ammonium phosphate, monobasic	–	C	A	A	A	A	A	A	–	A
dibasic	–	A	A	A	A	A	A	A	–	A
tribasic	–	A	A	A	A	A	A	A	–	A
Ammonium sulphate	A	C	A	A	A	A	A	A	–	A
Amyl acetate	A	A	C	X	X	X	–	F	C	A
Amyl alcohol	A	A	C	A	A	A	A	A	A	A
Aniline, aniline oil	A	A	–	X	F	X	A	X	–	A
Aniline dyes	A	A	–	F	F	F	A	F	–	A
Asphalt	F	A	–	X	F	F	X	X	F	A
Barium chloride	A	C	A	A	A	A	A	A	–	A
Barium hydroxide	A	A	A	A	A	A	A	A	F	A
Barium sulphide	–	A	–	A	A	A	A	A	–	A
Beer	A	A	X	A	A	X	A	A	A	A
Beet sugar liquors	A	A	A	A	A	A	A	A	A	A
Benzene, benzol	C	A	X	X	X	X	X	X	A	A
Benzine, petroleum ether, naphtha.	C	A	X	X	X	X	X	X	A	A
Black sulphate liquor	A	A	–	A	A	A	A	A	X	A
Blast furnace gas	C	A	–	C	C	C	C	A	X	A
Borax	A	A	A	A	C	F	A	A	A	A
Boric acid	–	A	A	A	A	A	A	A	–	A
Bromine	X	X	X	X	X	X	X	X	X	A
Butane	A	A	–	X	F	C	–	X	X	A
Butyl acetate	A	A	X	X	X	X	F	A	C	A
Butyl alcohol, butanol	A	A	C	A	A	A	A	A	X	A
Calcium bisulphite	C	C	A	A	–	C	A	–	–	A
Calcium chloride	A	C	A	A	A	A	A	A	A	A
Calcium hydroxide	A	A	A	A	A	A	A	C	F	A
Calcium hypochlorite	A	C	A	C	C	A	A	C	F	A
Caliche liquors	–	C	–	–	A	A	A	A	–	A
Cane sugar liquors	A	A	A	A	A	A	A	A	F	A
Carbolic acid, phenol	–	A	C	X	C	X	X	X	–	A
Carbon dioxide, dry	A	A	–	A	A	A	A	A	X	A
wet	A	A	–	A	A	A	A	A	X	A
Carbon bisulphide	A	A	–	X	X	X	X	X	X	A
Carbon monoxide, hot	A	A	–	C	C	C	C	C	C	A
Carbon tetrachloride	F	A	X	X	X	X	X	X	C	A
Castor oil	A	A	X	A	A	F	A	A	A	A
China wood oil, tung oil	A	A	X	X	F	A	–	X	C	A
Chlorine, dry	F	A	X	F	F	F	F	A	X	A
wet	F	X	X	F	F	F	F	X	X	A
Chlorinated solvents, dry	C	A	X	X	X	C	X	X	X	A
wet	C	A	X	X	X	C	X	X	X	A
Chloroacetic acid	–	X	X	–	–	–	–	–	–	A
Chlorosulphonic acid	C	X	X	X	X	X	X	X	X	A
Chromic acid	C	X	X	X	X	X	C	X	C	A
Citric acid	C	C	A	F	A	F	C	A	F	A
Coke oven gas	A	A	–	C	A	C	A	C	X	A
Copper chloride	A	C	A	A	F	A	A	–	–	A
Copper sulphate	A	C	A	A	A	A	F	A	A	A
Corn oil	A	A	X	X	F	A	A	X	C	A
Cotton seed oil	A	A	X	X	F	A	A	X	X	A
Creosote, coal tar	A	A	–	X	F	A	X	X	X	A
wood	C	A	X	X	F	A	X	X	X	A
Cresols, cresylic acid	–	A	X	X	X	X	X	X	–	A
Dowtherm, A	C	A	X	X	X	X	X	X	X	A
E	C	A	X	X	X	X	X	X	X	A
Ethers	A	A	X	C	C	C	C	X	X	A
Ethyl acetate	A	A	X	F	X	X	F	F	A	A
Ethyl cellulose	F	A	–	F	F	F	F	A	X	A
Ethyl chloride	A	A	–	A	A	A	A	A	C	A
Ethylene glycol	A	A	–	A	A	A	A	A	A	A
Ferric chloride	–	C	C	A	A	A	A	A	–	A
Ferric sulphate	–	C	C	A	A	A	A	A	–	A
Formaldehyde	C	A	C	A	C	A	A	A	F	A
Formic acid	–	X	C	A	X	X	A	A	–	A
Freon	C	A	–	X	F	A	F	X	C	A
Fuel oil	A	A	–	X	F	A	X	X	X	A
Fuel oil, acid	–	A	–	–	–	–	–	–	–	A
Furfural	C	A	–	X	X	X	–	X	X	A
Gasolene, sour	–	A	–	X	A	A	X	X	–	A
refined	C	A	–	X	A	A	X	X	X	A
Gelatin	A	A	A	A	A	A	A	A	A	A
Glucose	A	A	A	A	A	A	A	A	A	A
Glue	A	A	A	F	A	A	F	F	C	A
Glycerin, glycerol	A	A	C	A	A	A	A	A	A	A
Green sulphate liquor	A	A	–	A	A	A	A	A	X	A
Hydrobromic acid	–	C	–	X	–	–	–	A	–	A
Hydrochloric acid, <150 deg. F.	F	C	A	F	F	A	A	A	–	A
>150 deg. F.	X	C	C	X	F	X	–	F	–	A
Hydrocyanic acid	–	A	–	–	–	–	–	–	–	A
Hydrofluoric acid, cold, <65%	X	X	–	F	A	–	F	F	X	A
>65%	X	X	–	X	X	X	C	X	X	A
hot, <65%	X	X	–	C	A	–	C	C	X	A
>65%	X	X	–	C	C	–	C	C	X	A
Hydrofluosilicic acid	A	X	–	A	F	A	A	A	X	A
Hydrogen gas, cold	A	A	–	F	A	A	A	F	C	A
hot	A	A	–	F	A	A	A	F	C	A
Hydrogen peroxide	–	A	X	F	A	–	F	F	–	A
Hydrogen sulphide, dry, cold	–	A	X	C	F	C	A	C	–	A
hot	–	A	X	C	F	C	A	C	–	A
wet, cold	–	A	X	C	F	C	A	C	–	A
hot	–	A	X	C	F	C	A	C	–	A
Kerosene	A	A	X	C	F	A	X	C	C	A
Lacquers	C	A	X	X	X	X	X	X	X	A
Lacquer solvents	C	A	X	X	X	X	X	X	X	A
Lactic acid, cold	A	A	A	C	C	C	C	C	C	A
hot	A	C	A	C	C	C	C	C	C	A
Linseed oil	A	A	C	C	F	A	A	X	C	A
Lubricating oils, sour	A	A	C	F	A	A	X	F	C	A
refined	A	A	C	F	A	A	X	F	C	A
Magnesium chloride	A	C	C	A	A	A	A	A	C	A
Magnesium hydroxide	A	C	C	A	A	A	A	A	C	A
Magnesium sulphate	–	C	C	A	A	A	A	A	–	A
Mercuric chloride	–	C	C	–	–	–	–	–	–	A
Mercury	C	A	C	–	–	–	–	–	C	A
Methyl alcohol, methanol	A	A	C	A	A	A	A	A	A	A
Methyl chloride	C	A	–	C	A	C	A	C	–	A
Milk	–	A	X	A	A	A	A	A	–	A
Mineral oils	A	A	X	C	F	A	A	X	C	A
Natural gas	A	A	–	F	A	A	A	X	–	A
Nickel chloride	–	C	A	F	A	A	A	A	–	A
Nickel sulphate	–	C	A	A	A	A	A	A	–	A
Nitric acid, crude	C	X	X	X	X	X	C	X	–	A
diluted	C	X	X	X	X	X	A	X	–	A
concentrated	X	X	X	X	X	X	C	X	–	A
Nitrobenzene	–	C	–	X	X	C	X	X	–	A
Oleic acid	A	A	–	F	A	A	–	F	–	A
Oleum spirits	–	X	X	–	–	–	–	–	–	A
Oxalic acid	A	X	A	F	–	–	–	F	C	A
Oxygen, cold	A	A	–	C	A	C	–	C	C	A
<500 deg. F.	C	A	–	C	C	–	–	C	X	X
500–1,000 deg. F.	–	A	–	–	–	–	–	X	–	X
>1,000 deg. F.	X	X	–	X	X	X	X	X	X	X
Ozone	–	–	–	–	–	–	–	–	–	–
Palmitic acid	A	A	–	F	A	A	F	F	C	A
Petroleum oils, crude, <500 deg. F.	A	A	X	C	X	X	X	C	X	X
>500 deg. F.	C	A	X	C	X	X	X	C	X	X
>1,000 deg. F.	X	C	X	X	X	X	X	X	X	X
Phosphoric acid, crude	A	X	C	C	C	C	C	C	–	A
pure, <45%	A	X	C	C	C	C	C	C	–	A
>45%, cold	A	X	C	C	C	C	C	C	–	A
hot	–	X	C	C	C	C	C	C	–	A
Picric acid, molten	A	C	–	C	C	C	C	C	C	A
water solution	A	X	C	C	A	A	A	A	A	A
Potassium chloride	–	A	A	A	A	A	A	A	–	A
Potassium cyanide	–	A	–	A	A	A	A	A	–	A
Potassium hydroxide	–	A	C	A	A	A	A	A	–	A
Potassium sulphate	–	A	A	A	A	A	A	A	–	A
Producer gas	A	A	–	–	–	–	–	–	–	A
Propane	A	A	–	–	F	A	–	–	–	A
Sewage	A	A	–	C	F	A	X	C	C	A
Soap solutions	C	A	A	C	F	A	–	C	C	A
Soda ash, sodium carbonate	A	A	A	A	A	A	A	A	A	A
Sodium bicarbonate, baking soda	A	A	A	A	A	A	A	A	A	A
Sodium bisulphate	A	C	A	A	A	A	A	A	A	A
Sodium chloride	A	A	A	A	A	A	A	A	A	A
Sodium cyanide	–	A	–	A	A	A	A	A	–	A
Sodium hydroxide	A	A	A	C	C	C	A	C	C	A
Sodium hypochlorite	A	C	A	A	C	C	A	C	C	A
Sodium metaphosphate	A	C	A	A	C	C	A	A	A	A
Sodium nitrate	C	C	A	A	C	C	C	A	–	A
Sodium perborate	C	A	–	C	C	C	A	C	–	A
Sodium peroxide	C	A	–	C	C	C	A	C	–	A
Sodium phosphate, monobasic	A	C	A	A	C	C	A	A	A	A
dibasic	A	A	A	A	C	C	A	A	A	A
tribasic	A	A	A	A	C	C	A	A	A	A
Sodium silicate	A	A	A	A	C	C	A	A	–	A
Sodium sulphate	A	A	A	A	A	A	A	A	–	A
Sodium sulphide	A	A	–	A	A	A	A	A	–	A
Sodium thiosulphate, "hypo"	A	A	A	A	–	A	A	A	A	A
Soybean oil	A	A	–	C	A	A	A	C	C	A
Stannic chloride	A	X	A	A	A	A	F	A	C	A
Steam, <500 deg. F.	A	A	–	A	C	X	A	C	X	A
500–1,000 deg. F.	C	A	–	X	X	X	–	X	X	X
>1,000 deg. F.	X	C	–	X	X	X	–	X	X	X
Stearic acid	A	A	X	X	C	A	C	F	C	A
Sulphur	A	A	–	F	X	A	F	F	C	A
Sulphur chloride	C	X	–	X	F	X	F	X	C	A
Sulphur dioxide, dry	A	A	–	C	C	F	C	C	C	A
Sulphur trioxide, dry	–	A	–	C	C	C	C	A	–	A
Sulphuric acid, <10%, cold	A	F	A	C	A	A	C	A	–	A
hot	A	F	X	A	C	C	A	A	–	A
10-75%, cold	F	X	X	C	C	C	C	C	–	A
hot	F	X	X	C	C	C	A	C	–	A
75-95%, cold	C	X	X	X	C	C	C	X	X	A
hot	C	X	X	X	X	X	C	X	X	A
fuming	X	X	X	X	X	X	C	X	–	A
Sulphurous acid	A	X	A	C	C	C	C	A	–	A
Tannic acid	–	A	A	C	C	C	X	C	X	A
Tar	A	A	–	C	C	C	C	A	–	A
Tartaric acid	–	A	A	X	C	X	X	X	X	A
Toluene	A	A	X	X	F	C	A	X	X	A
Trichloroethylene	C	A	X	X	C	A	X	C	X	A
Turpentine	A	A	X	A	X	X	X	C	C	A
Vinegar	A	A	A	C	C	C	A	C	X	A
Water, acid mine, cont'g oxidizing salts or no oxidizing salts	A	A	A	A	C	A	A	A	C	A
Water, fresh (tap, b'l'r f'd, etc.)	A	A	A	A	C	A	A	A	A	A
distilled, lab. grade	A	A	X	A	C	A	A	A	A	A
return condensate	A	A	C	A	C	A	A	A	A	A
Water, seawater	A	A	X	A	C	A	A	A	A	A
Whiskey and wines	A	A	X	A	C	A	A	A	A	A
Zinc chloride	C	X	A	A	C	A	A	C	A	A
Zinc sulphate	A	X	A	A	A	A	A	A	A	A

Chemical Resistance of Gasket Materials

This chart enables you to select accurately the right "U.S." Gasket for corrosion service

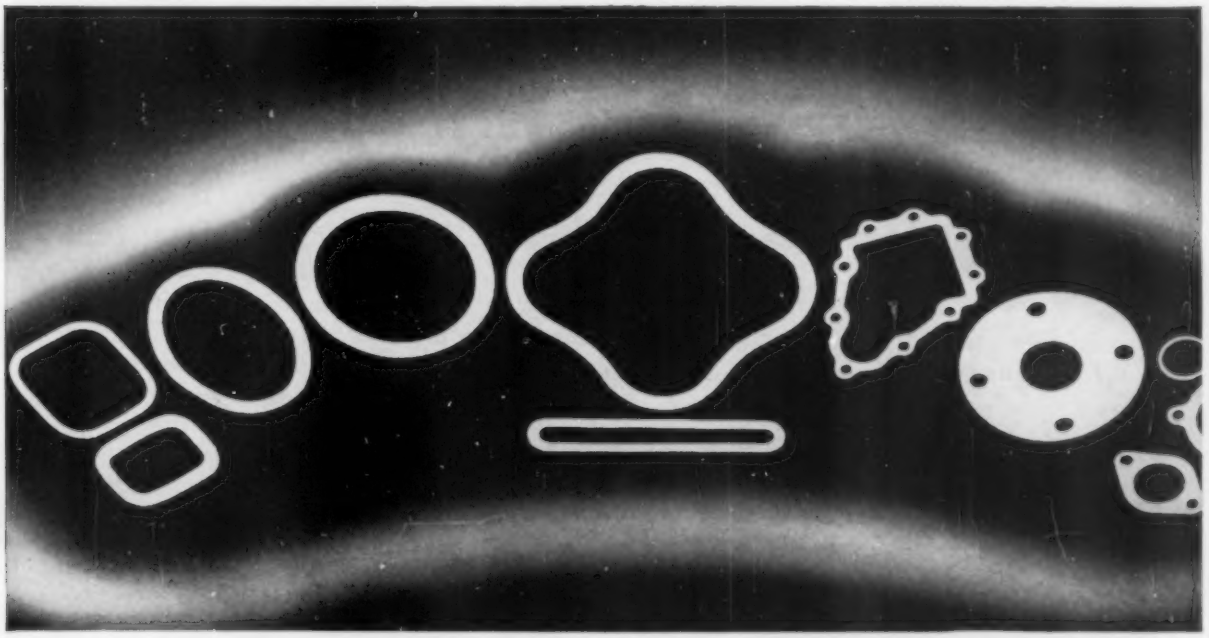
SEND FOR YOUR FREE REPRINT

The chart will be useful in indicating the degree of safety with which the various materials may be used in the service shown.

Those materials known to be suitably resistant have been rated as "A." Those whose resistance is only fair, but not so low as to be dangerous, have been given an "F" rating. An "X" denotes that the material is totally unsuitable. The "C" rating means that the use of this material is dependent upon specific service conditions and should not be selected unless carefully investigated. The blank spaces for the most part represent absence of data.

The generally accepted temperature limit for a good grade compressed asbestos sheet, also called asbestos composition sheet, is 750 deg. F. However, some grades are successfully used at considerably higher temperatures. This type of sheet is used for smooth flanges. For rough flanges, gaskets cut from woven asbestos-metallic sheet or gaskets formed by folding asbestos-metallic cloth are preferred. The latter material is preferable for flanges when bolt pressures are necessarily limited due to the type of flange material.

The all-rubber materials are recommended for temperatures up to 300° F. Higher temperatures are sometimes used but with a lesser degree of safety. Pressures are determined by the type of flange surface.



Examples of U. S. Rainbow Gaskets, Style No. 4009

Outstanding members of the "U. S." line of gaskets. Recommended for packing flanges or other parallel surfaces against hot or cold water, air, saturated steam pressures up to 150 pounds, and all hydraulic conditions.

These gaskets are cut from U. S. Rainbow® Sheet Packing, Style No. 9. They have all the resiliency, pliability and adaptability of the famous Rainbow original Red Sheet Packing. Furnished in any shape, size or thickness.

U. S. Packings and Gaskets are obtainable through any of our 27 District Sales Offices or selected "U. S." distributors.

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this die casting had a "deadline"...

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From drawing board to final polishing, this Revere projector housing was a race against the clock. It had to be ready in time to meet a "rush" production schedule—and it was. We can beat deadlines for you, too, if necessary. Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . . **Designing • Engineering • Die Making Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.**

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Fixed and "Dividohm" adjustable wire-wound types, 10 to 200 watts. Also composition type.

RHEOSTATS
Ten stock sizes—25 to 1000 watts. All ceramic and metal.

TAP SWITCHES
Rotary type. Five sizes from 10 to 100 amp, with from 2 to 12 taps.

What resistance components do you need in a hurry? From a factory stock of several million resistors, rheostats, and tap switches . . . in 1,859 types, sizes, and values . . . Ohmite can make fast delivery in reasonable quantities to meet your immediate requirements.

Furthermore, by tailoring your specifications to these stock items, you can always get speedy delivery that will help you keep experimental and pilot production operations on a smooth-running schedule.

To assist engineers and purchasing agents in making their selection from this huge stock, Ohmite *Stock Catalog* No. 24 contains complete, up-to-date information on all Ohmite stock items. Resistance values, ratings, specifications, and other helpful information are included.

NEED RELAYS? Ohmite Amrecon Relays are available in 61 stock types. Write for Bulletin R-26.

SEND FOR STOCK CATALOG NO. 24

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1925-1955

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OHMITE® *Power Type* RESISTORS

CORRIB®

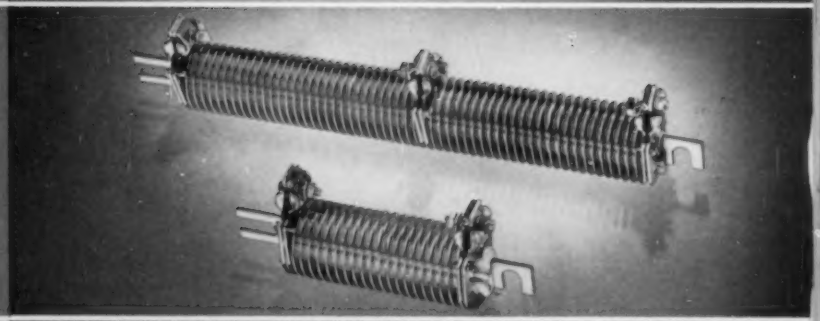
Vitreous-Enameled, Corrugated-Ribbon Type

Special Ohmite vitreous enamel locks the edge-wound ribbon alloy to a sturdy ceramic core. Fixed, tapped, and adjustable types. Available in 22 sizes from 90 to 1500 watts. Resistance values range from .04 to 70 ohms.

POWR-RIB®

Edgewound-Ribbon Type

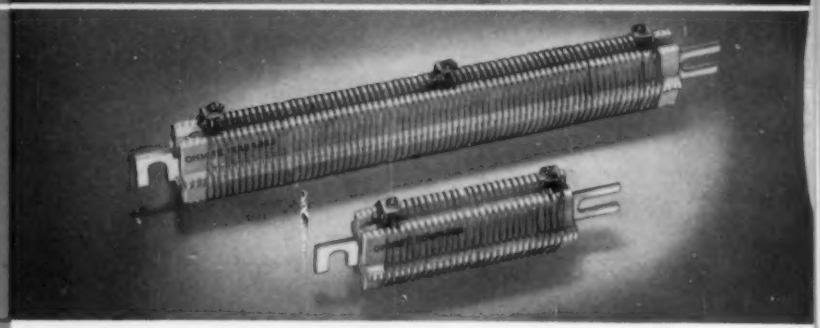
Has a heavy ribbon of resistance alloy, edge-wound on a ceramic core. Core is sectionalized for flexibility and shock resistance. Terminals and brackets are plated to prevent oxidation. Four sizes in resistances from .043 to 1.6 ohms; and from 24 to 95 amperes.



POWR-RIB®

Round-Wire Type

Similar in construction to Ribbon-Wire type shown above, but with round resistance wire. Sturdy ceramic core is made in two to five sections. Available in four sizes. Resistance values from .69 to 25 ohms. Current ratings from 5.1 to 18.4 amperes.



Write for Bulletin 144

Available in fixed or adjustable "DIVIDOHM®" Types.

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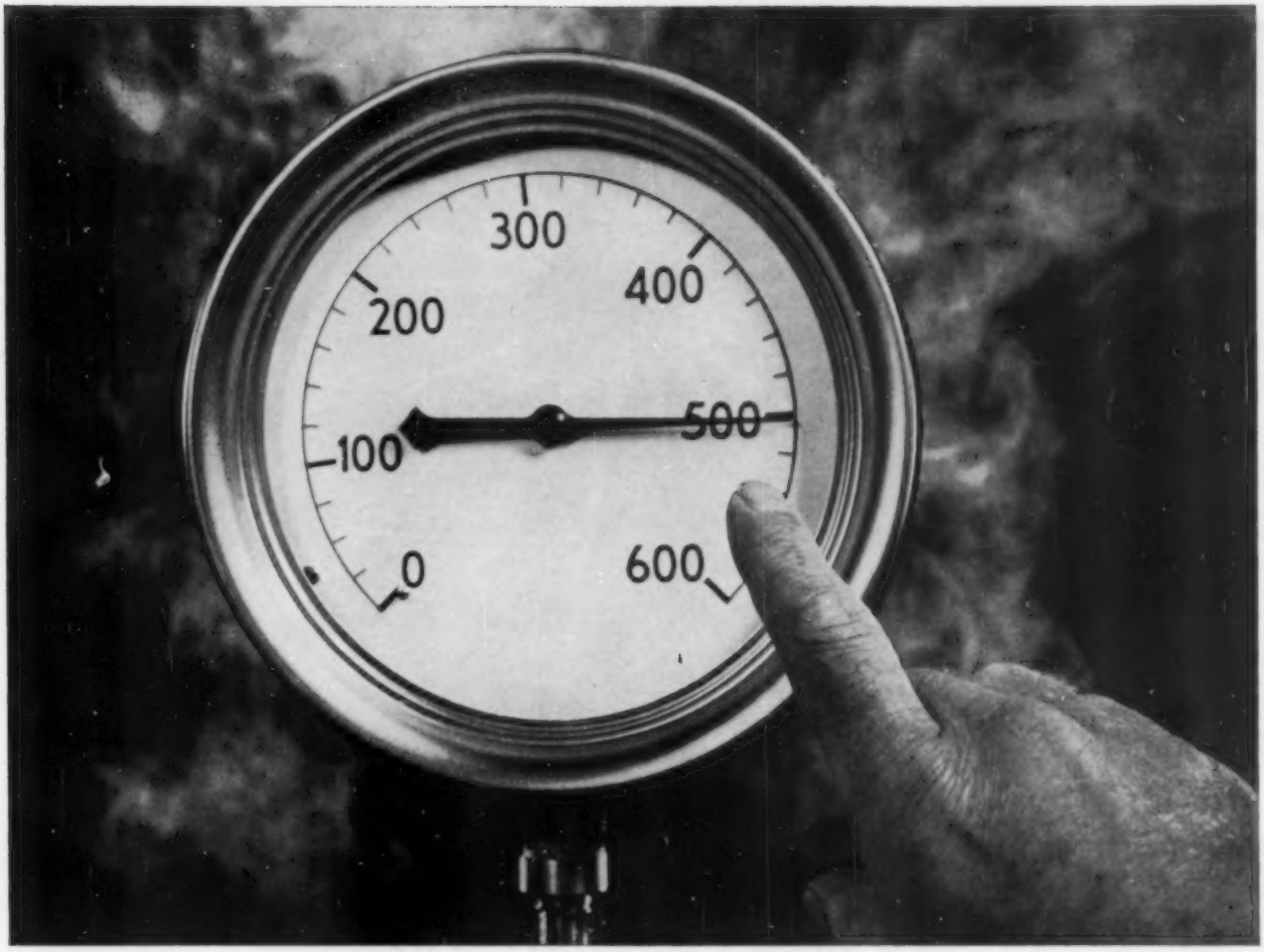

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Nylon • "Dacron"† • Glass
Cotton • "Orlon"‡ • Asbestos

Glass fabrics coated with "Teflon" tetrafluoroethylene resin, elastomer sheet stocks and cements

†Du Pont's trade-mark for its polyester fiber.
‡Du Pont's trade-mark for its acrylic fiber.

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Take the case of Mr. J., candy manufacturer. He needed a conveyor belt that could withstand the high temperature of molten peanut brittle—and have the "release" necessary for easy removal of the candy after cooling. Technicians of the Du Pont Fabrics Division developed the answer—a *coated fabric* that combined both properties.

"Fairprene" Industrial Products are a wise choice for "tough" jobs where ordinary belts, diaphragms, seals, or protective cloth materials fail prematurely. With the proper fabric and coating, you can obtain the exact combination of properties your application demands. Whether you need resistance to oil or heat . . . abrasion or flex cracking . . . there's a coated fabric that's *right* for the job.

Look into "Fairprene" Industrial Products before you start your next design. We'll be glad to discuss them with you. Just clip and mail the coupon for further information.

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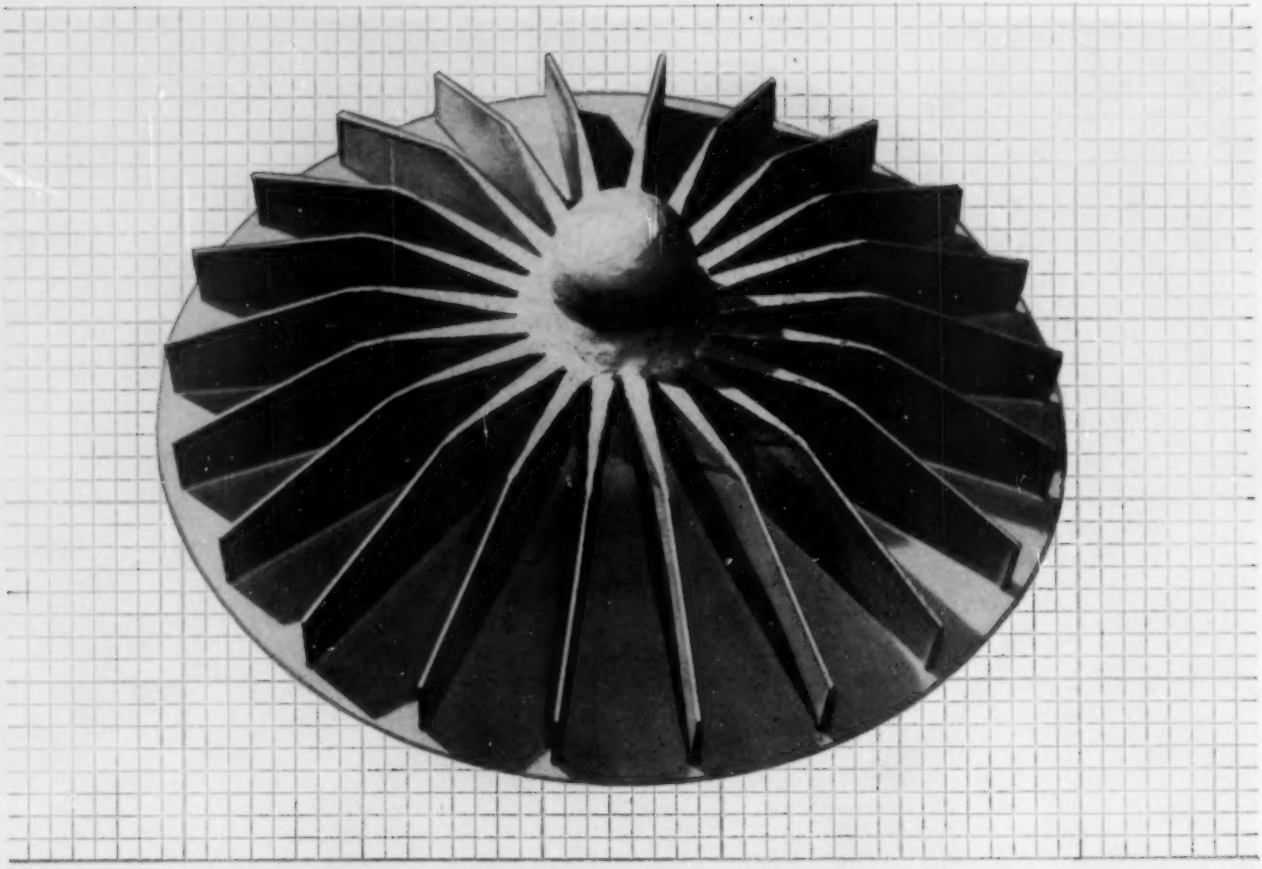

22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

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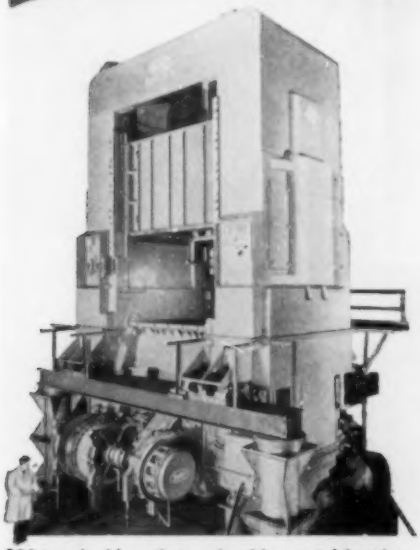
EDDY-CURRENT EQUIPMENT

is Solving Speed Control Problems in Every Major Industry



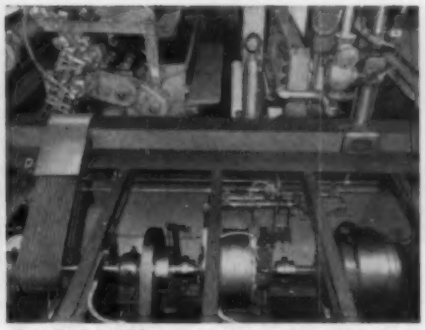
800 ton double-action under-drive metal forming press, driven by Dynamatic model 37-32 combination eddy-current coupling and brake.

In practically all testing, processing, and conveying equipment common to industry, Dynamatic eddy-current rotating equipment is solving a wide range of adjustable speed drive problems, particularly where an AC power source is a requirement.

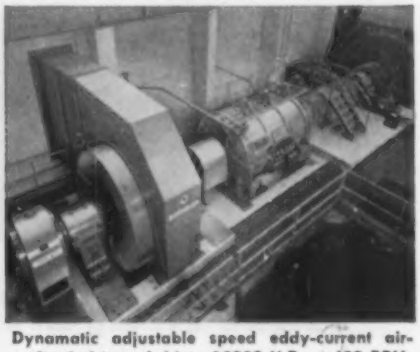
Advantages include rapid response, stepless adjustable speed control, wide speed range, quiet operation, low power loss, low maintenance cost, adjustable speed from an AC power source.

Send for Bulletin GB2, which describes and illustrates the basic Dynamatic eddy-current units, including couplings, brakes, dynamometers, press drives, and Ajusto-Spede® drives.

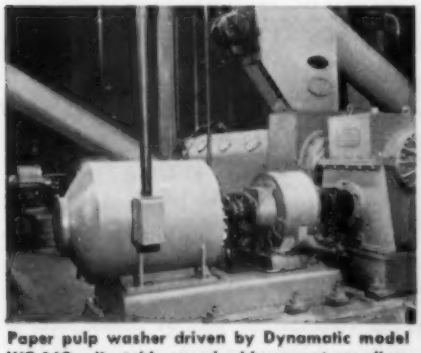
Tandem Dynamatic dynamometers, rated 20000 H.P., 600 to 5800 RPM. A cradled gear box permits turbine testing to 15000 RPM.



Model WC-130B Dynamatic adjustable speed eddy-current coupling with eddy-current brake, used as printing press drive. Rated 20 H.P at 1700 RPM.

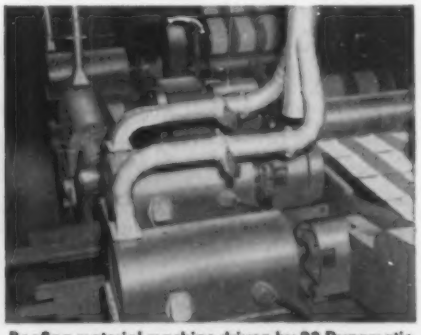


Dynamatic adjustable speed eddy-current aircraft wind tunnel drive, 18000 H.P. at 480 RPM.



Paper pulp washer driven by Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 125 H.P. at 1100 RPM.

Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 100 H.P. at 1100 RPM, used as cement kiln drive.



Roofing material machine driven by 23 Dynamatic Ajusto-Spede® drives. All drives and controls completely enclosed and force ventilated.

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Mayari R makes it lighter... stronger... longer lasting

How Mayari R gave extra strength to these 75-foot Van-Cars

These new Van-Cars,* each 75 ft long, are carrying trailers in the new "TrucTrain" service that the Pennsylvania Railroad has inaugurated, with The Rail-Trailer Co. acting as coordinator between the railroad and motor common carriers.

Because of the unusual length of these cars they had to be extra-strong between bolsters, yet without excessive weight. For this reason, load-bearing members such as center sills, side sills, stringers and crossties were built of Mayari R high-strength, low-alloy steel. With half again the strength of carbon structural steel, these and other Mayari R members supplied ample strength while holding the weight down to 79,000 lb per car.

More and more Mayari R is becoming the choice for railway cars and motive power, automotive vehicles and trailers,

*Van-Car Corporation, which owns these cars, is the car-leasing subsidiary of The Rail-Trailer Co.

These specially-designed cars are 75 ft long, have a capacity of 125,000 lb. Hinged ramps at car ends allow end-loading in strings.

as well as a host of industrial applications. It is readily welded and worked, and holds paint up to 80 pct longer than plain carbon steel. Catalog 353 shows dozens of outstanding applications of Mayari R, some of which probably have a bearing on a problem confronting you. A phone call or note will bring you a copy promptly.

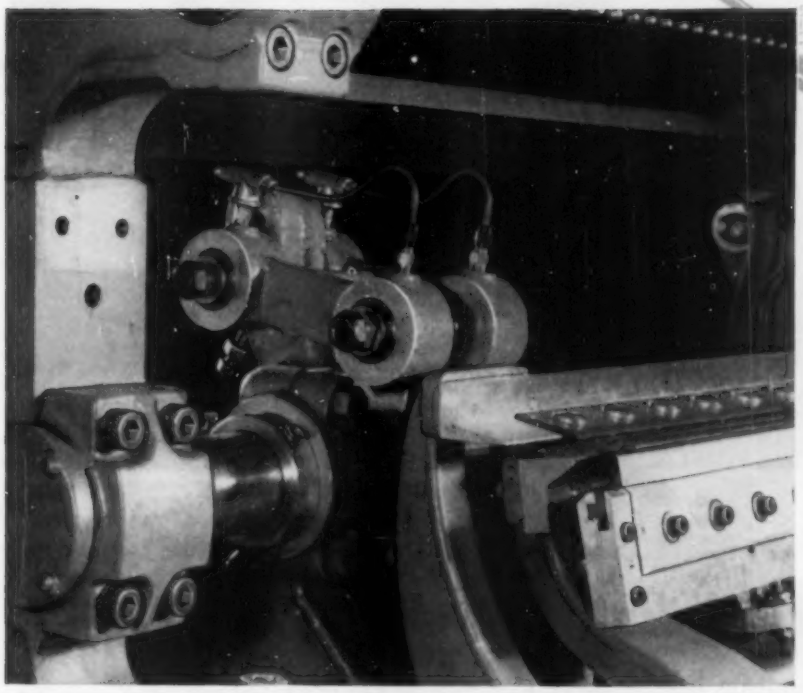
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

P-K "proving ground" for

ASSEMBLY STRENGTH



STAY TIGHT UNDER TOUGHEST CONDITIONS

In the warp knitting machine, above, P-K Socket Screws stay tight under constant vibration. Some of many different P-K Socket Screws used are shown — P-K Cap Screws in shaft bearing pads and needle bar clamps, and P-K Set Screw in collar on needle bar rocker shaft.

The "proving ground" for the holding power of P-K Socket Screws is industry-wide. Millions of assemblies made by thousands of satisfied customers are your assurance that screws made to P-K quality standards meet every test.

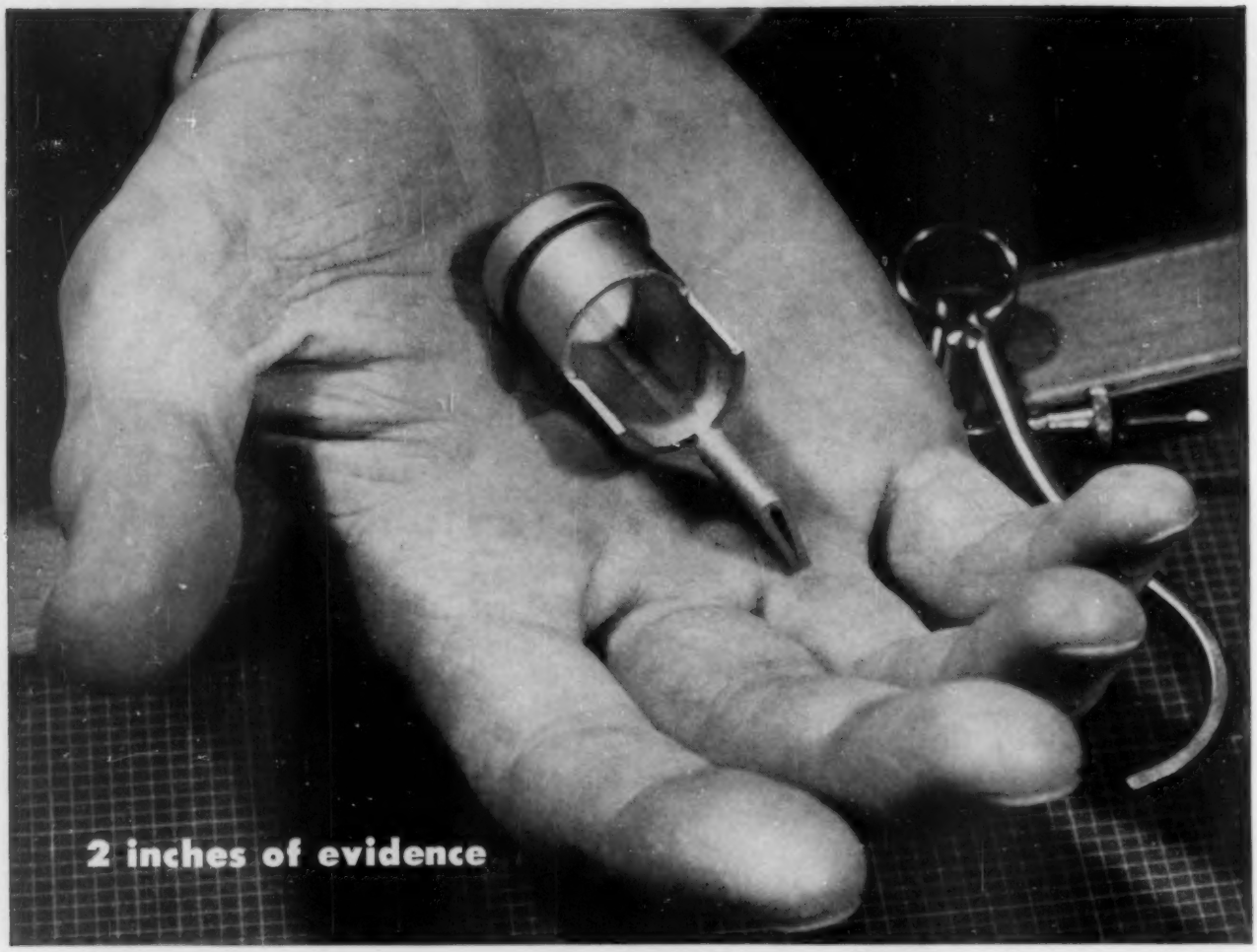
In many of these assemblies, P-K Socket Screws are subjected to extreme conditions of shock and vibration . . . such as ordnance and other products made to exacting demands of the Armed Forces.

Get samples, information from your P-K Distributor, or write: Parker Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

PARKER-KALON®

SOCKET SCREWS

Remember **P-K** means **OK**



. . . Why *Carpenter* Stainless Tubing Quality Helps Solve Design and Fabrication Problems

In the Carpenter mill a length of ⅝" I.D. tubing was selected at random. A 2¼" length was cut from one end. ¼" of this sample was then turned back upon itself. Properly spaced saw cuts were made at the other end of the sample and the defined area folded bookwise with the tube weld at the point of the fold.

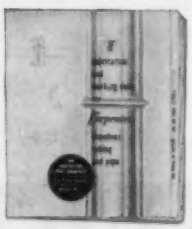
You can see the result pictured above. There are no cracks or splits at the rolled end. No trace of failure can be detected where the sample was folded at the weld.

What does this mean to you?

It means that if you are designing a part that can be bettered by the use of stainless tubing, Carpenter quality frees you from most design limitations.

It means, too, that if you are fabricating parts from stainless tubing, buying Carpenter is an easy way to insure trouble-free production even when severe working is required.

In short, there's a real difference in stainless tubing and Carpenter makes that difference. Why not examine the evidence yourself, in your own shop? Contact your Carpenter Distributor or nearest Carpenter Representative—he'll have one of these "reverse bend" samples to show you—can give you complete information on Carpenter Stainless Tubing and Pipe.



New guide to fabricating and working stainless tubing and pipe

Described and illustrated are shop-proved methods of performing sixteen different operations. A copy is yours for the asking. Send for Bulletin T. D. 114.

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

more than corrosion resistance

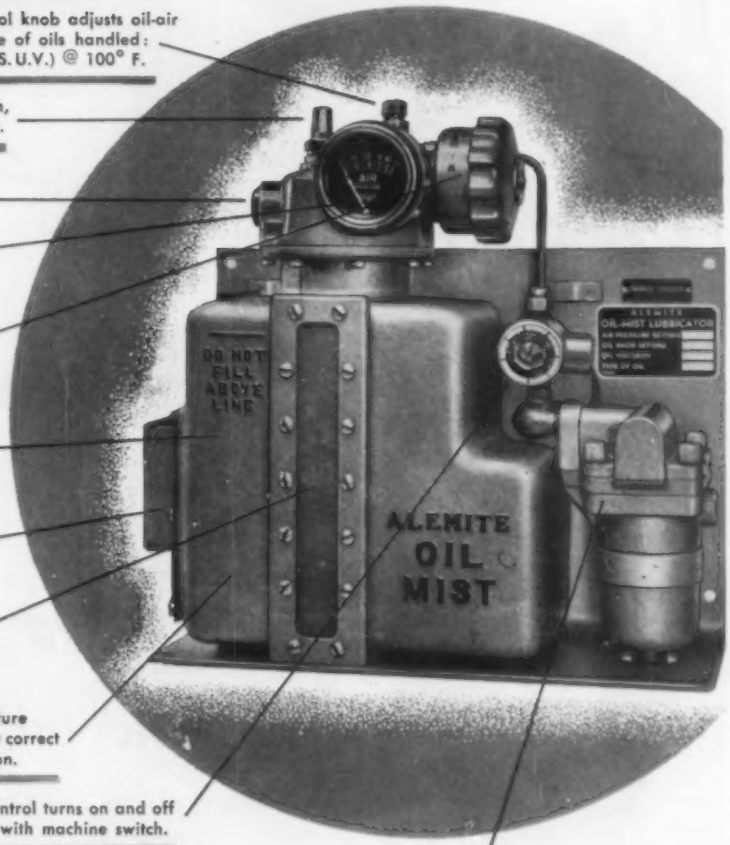
Stainless Tubing & Pipe

You asked for it!
Designers told us what industry had to have!

ALEMITE OIL-MIST

Proved in countless applications – multiplies bearing life – slashes product spoilage – boosts machine output!

Hundreds of case histories prove savings, ease of installation, increased output with Oil-Mist. And Oil-Mist is simple to design into any machine. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts – vees, chains, slides, gears, all types of bearings. Replaces grease systems. No moving parts – operates on compressed air – completely automatic, fool-proof!



1. Oil flow control knob adjusts oil-air mixture. Range of oils handled: to 1,000 sec. (S.U.V.) @ 100° F.
2. Loader fitting for fast, clean, filtered refilling of reservoir.
3. Oil-Mist delivery outlet for main line leading to bearings.
4. Air gauge registers to 50 psi.
5. Air regulator—operating pressure 5 to 20 psi. Reduces pressures from up to 200 psi. Normal air consumption, .7 to 1.2 cfm.
6. Reservoir capacity one gallon. Also available in 12 oz. size.
7. Low level indicator switch turns on warning signal or stops the machine when oil level is low.
8. Nylon plastic window gives visible check of oil supply.
9. Heater for outdoor or low temperature applications. Thermostat keeps oil at correct temperature for efficient atomization.
10. Solenoid air control turns on and off simultaneously with machine switch.
11. Moisture separator and filter removes up to 98% of moisture from incoming air at flow rate up to 1 cfm.

Complete range of models and multiple unit models to fit any machine – any application

Three types of bearing fittings allow the use of OIL-MIST on any machine!

Oil-Mist fittings bring the most efficient lubrication in the world to any anti-friction bearing—roller, ball, needle.

Spray fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where needed.

Condensing fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rollers.

Alemite Oil-Mist offers these lubrication advantages

Automatic lubrication • Continuous lubrication
Eliminates guesswork • Greater safety • Cuts oil consumption up to 90%
Extends bearing life • Stops oil drippage • Saves man-power
Reduces number of lubricants needed • Eliminates "Down-time"

FREE ... *write today!*

Use coupon below for your free copy of the Oil-Mist catalog and data book!

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Company .....
Address .....
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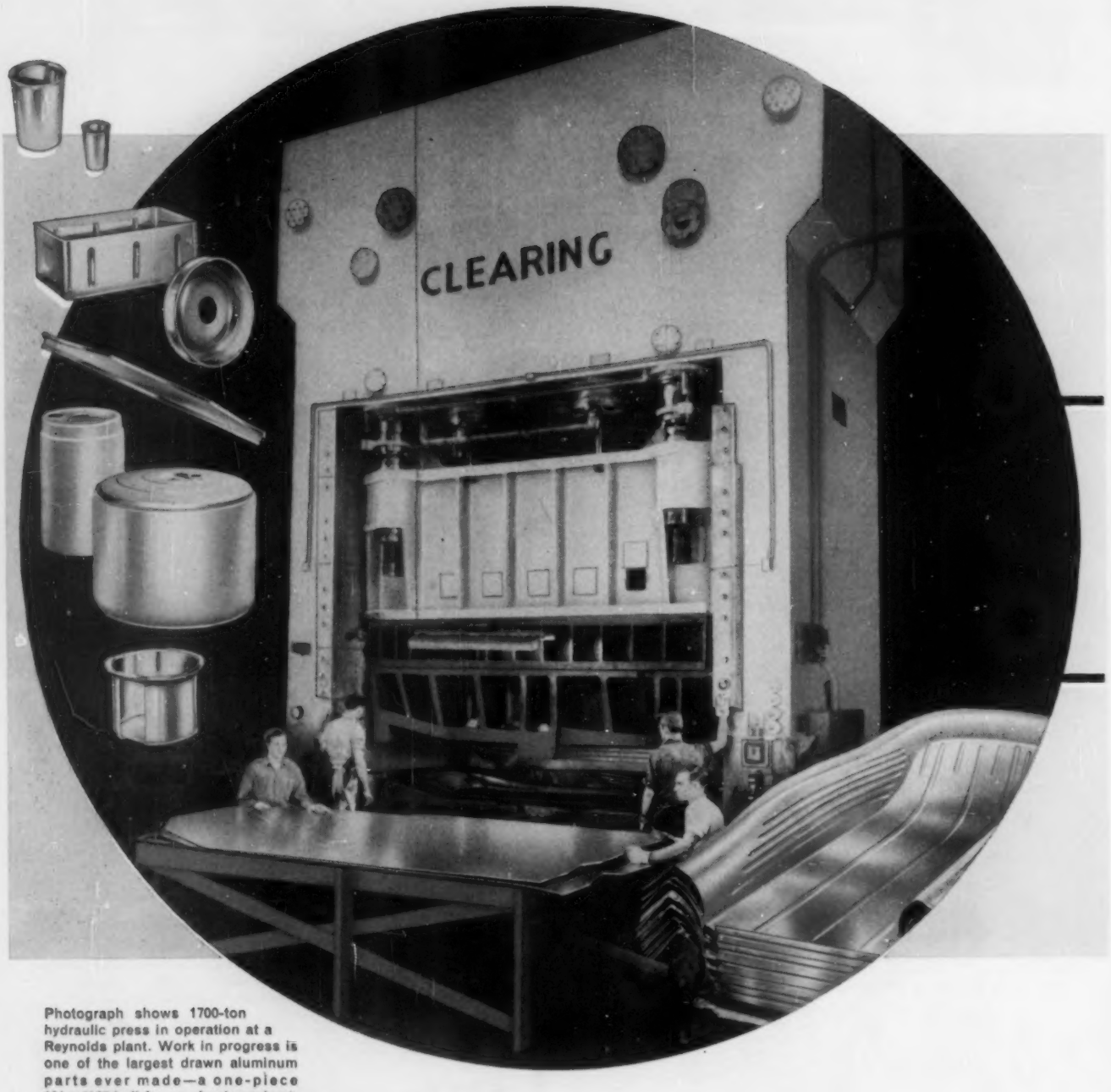
ALEMITE OIL-MIST LUBRICATION

A PRODUCT OF SW STEWART WARNER

from tumblers to trailers...get the most

ALUMINUM



Photograph shows 1700-ton hydraulic press in operation at a Reynolds plant. Work in progress is one of the largest drawn aluminum parts ever made—a one-piece 12' x 4'8" hull for an aluminum boat. This press is currently producing other drawn parts 6' in diameter.

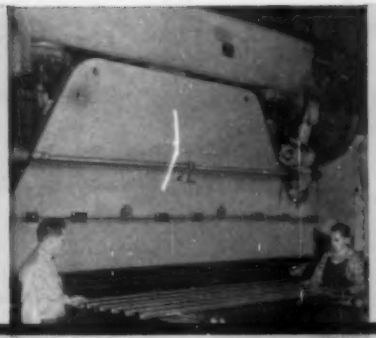
REYNOLDS ALUMINUM

BLANKING · EMBOSSING · STAMPING · DRAWING · RIVETING · FORMING · BRAZING

from your designs with

PRESS PARTS

from REYNOLDS



Square corrugated trailer siding is being fabricated here on a brake press. Brake presses from 22½ to 300 tons are available for your requirements by Reynolds Aluminum Fabricating Service.

Washing machine tubs being fabricated here are one example of countless quality parts that can be produced to your specifications by Reynolds Aluminum Fabricating Service.

Here is part of a battery of medium presses in a Reynolds plant. Large, medium or small—Reynolds Aluminum Fabricating Service has presses to fit your every need.

If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing or other press operations, Reynolds Aluminum Fabricating Service can produce these parts to your specifications quickly, efficiently and economically.

The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

In two plants alone, out of the more than 30 Reynolds plants in 18 states, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Ky.*

FREE:

Write for your copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

See Reynolds "Do-It-Yourself" program, Sunday nights on NBC-TV

FABRICATING SERVICE

ROLL SHAPING · TUBE BENDING · WELDING · FINISHING · IMPACT EXTRUDING

Progressive manufacturers of refrigeration and air conditioning equipment have found they can obtain many of the numerous metal products they need from one supplier—Revere. In aluminum . . . coiled sheet for condenser and evaporator fins, and other parts. Embossed sheet for freezer compartment linings and shelves. Extruded shapes for mouldings and structural elements. Tube for fluid lines. Forgings for fittings and moving parts. Foil if desired for reflective insulation and other uses. And copper tube also, for fin and tube assemblies, as well as capillary tube.

Whatever your own products may be, if you are using or planning to use aluminum, brass or copper, you will find the Revere metals and the Revere Technical Advisory Service of special value in today's competitive market. Revere Copper and Brass Incorporated, founded by Paul Revere in 1801. Executive Offices, 230 Park Avenue, New York 17, N.Y.

REVERE KNOWS ITS A-B-C'S

ALUMINUM BRASS COPPER

FLEXLOC AT WORK

Power Hack Saw Builder Fastens blade guides with FLEXLOC self-locking nuts. Eight of these one-piece, all-metal locknuts are used in this assembly. And they won't work loose, regardless of vibration.

You can get the same dependable service. FLEXLOCs come in a wide range of sizes, types and materials. They are stocked by leading industrial distributors everywhere. Ask your local man for Bulletin 866. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

• • •

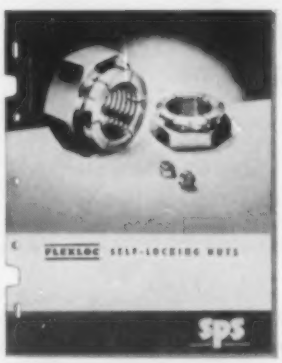
Use FLEXLOCs anywhere:

ON ROUGH BOLTS. FLEXLOCs smooth out bolt threads without damaging their own threads.

IN TEMPERATURES TO 550° F. in plated nuts and even higher in unplated ones. High temperatures do not affect FLEXLOCs. Nuts with non-metallic inserts fail under such conditions.

AS LOCK OR STOP NUTS. After at least 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC stays put.

REGARDLESS OF MOISTURE, OIL, DIRT AND GRIT. Even conditions like these do not affect the locking ability of FLEXLOCs.



FLEXLOC®
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA

Design for Efficiency with Double-Enveloping Worm Gearing

Reduce size and cost of your drive systems by utilizing this outstanding method of power transmission

Designers today can choose from two general types of worm gearing for use in drive systems. These types (Fig. 1) include:

1. Gearing with one element throated.
2. Gearing with both elements throated.

In cylindrical worm gearing, only one element is throated. Contact between teeth is a theoretical line, varying in length with tooth design. One member is involute in form, the other straight-sided. Under load, the line contact widens to a thin band or zone of contact.

When both elements are throated, or double enveloping, all teeth are straight-sided and tangent to a common circle, and in contact the full depth of the teeth. As a result, we have line contact across the face plus a line contact extending full depth of the teeth. The resulting area contact occurs on all teeth in mesh, giving multiple-tooth area-contact. Basically, this means higher load-carrying capacity than possible with other types of gearing.

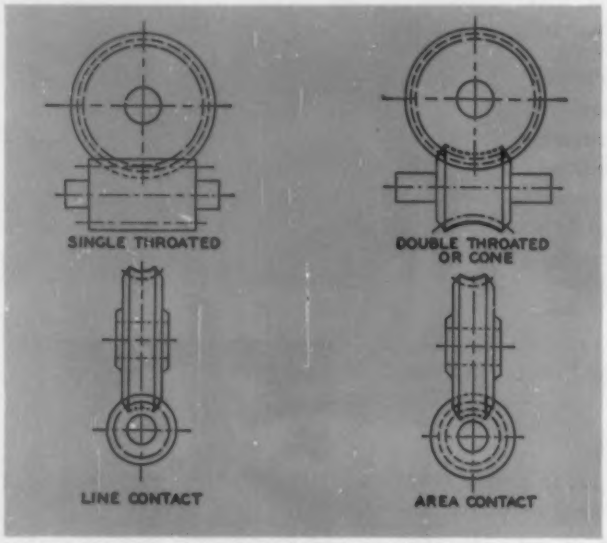


FIG. 1—Comparison of double-enveloping design (both elements throated) of Cone-Drive gearing with cylindrical worm gearing.

We call these double-enveloping worm gears "Cone-Drive" gears. They possess another feature possible only with the double-enveloping design—the ability to regenerate or reproduce themselves when wear occurs.

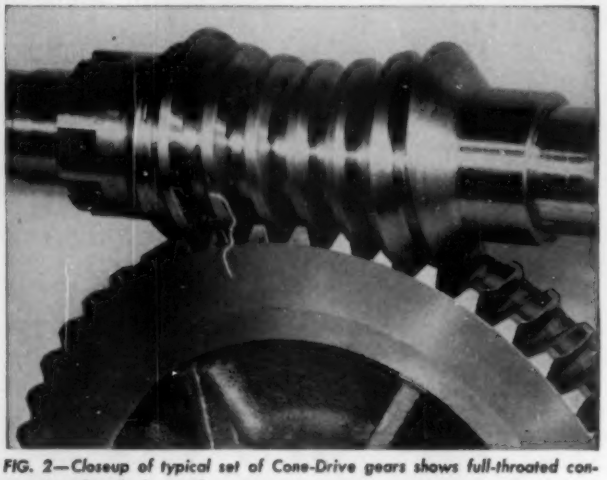


FIG. 2—Closeup of typical set of Cone-Drive gears shows full-throated construction of each element for area contact.

With Cone-Drive gears, total contact area and combined tooth strength have the same values for any given center distance regardless of the ratio used. For any given center distance, the smaller the number of teeth the larger each individual tooth and vice-versa.

The number of teeth in contact is always ⅛ of the total on the gear. If there are 48 teeth on the gear, 6 will be in engagement at all times. Reduce the teeth to 24 and there will be 3 in engagement—but each tooth will be twice as large.

What does this double-enveloping or wrapping of one gear around the other mean to the designer?

COMPACT BUT POWERFUL

By spreading the load over a greater contact area, Cone-Drive gears reduce unit pressures. Gearsets can have much smaller center distances—carry loads that require cylindrical gearing that is much larger and heavier (up to three times as much.) This also means that housings can be smaller, weight reduced and the product made more compact.

It is often possible to replace large, bulky gear trains with standard Cone-Drive gears because of their ability to handle large loads with high reductions on small center distances. Again the result is increased compactness and, very often, much lower cost for a better product.

AVAILABLE IN MANY SIZES, RATIOS AND TYPES

Cone-Drive gears are available in many forms. These include:

1. **Gearsets (444 standardized sets)**
2. **Speed reducers (over 190,000 standardized models)**
   - **Standard . . . . . shaft over, under or vertical**
   - **Shaft-mounted . . . . . shaft over, under or vertical**
   - **Fan-cooled . . . . . shaft over, under or vertical**
   - **Double-reduction . . . . . shaft over, under or vertical**
   - **Motorized . . . . . shaft over, under or vertical**
3. **Ratios from 5:1 to 4900:1**
4. **Loads from fractional to 800 hp**

All parts for a given center distance—gears, mountings, bearings, housings, fan-cooling attachments and water cooling coils (for continuous high-load operation), etc.—are standardized whether you require pinion under or over, gear shaft vertical or horizontal, single or double-extended shafts, right or left hand.

SMOOTH OPERATION FEATURED

Cone-Drive gears provide power transmission as smooth or smoother than the finest hydraulic system. The large number of teeth in continuous contact are responsible for this feature. When desired, these gears can be made "self-locking" so that no movement takes place in either direction of rotation of the gear unless power is applied to the worm.

With a tooth shape that gives maximum strength where needed plus full-depth engagement, Cone-Drive gears resistance to shock loads is remarkable. Ratings for continuous shock load service are high. Maintenance consists primarily of proper lubrication. The regenerating or "wearing-in" feature also adds greatly to life.

ASSEMBLY NO PROBLEM

A question is sometimes raised, because of the double-enveloping design, as to the accuracy to which the end position of the Cone-Drive pinion must be held in assembly. This accuracy is directly related to the size of the gear set. The average gear is approximately 4 times the size of the pinion. Thus, accuracy of end location of the pinion is only ¼th as critical as the side position of the gear. Accuracy required for side position and center distance of Cone-Drive gears is the same as for cylindrical worm gearing. When side position location of the gear is provided for as in all worm gears, the additional dimension providing end position location of the worm requires only ¼th the accuracy. For instance, the lead of a 6" center distance worm changes only 0.0007 in. for an end movement of the worm of 0.010 inch.

ADD SALES APPEAL

Industry and its customers have steadily come to recognize the many advantages of Cone-Drive gearing in the products they buy. Many manufacturers today give prominence to their use of Cone-Drive gears in product literature and advertising, taking advantage of their inherent sales appeal and desirability.

Whether you want gearsets for built-in application, standard single-reduction speed reducers, double-reduction reducers, shaft-mounted reducers, motorized reducers, or fan or water-cooled reducers, Cone-Drive Gears has them in stock. All parts are available from stock if you should ever need them. All bearings are standard, too.

Ask for Bulletin 789-54 for additional information.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

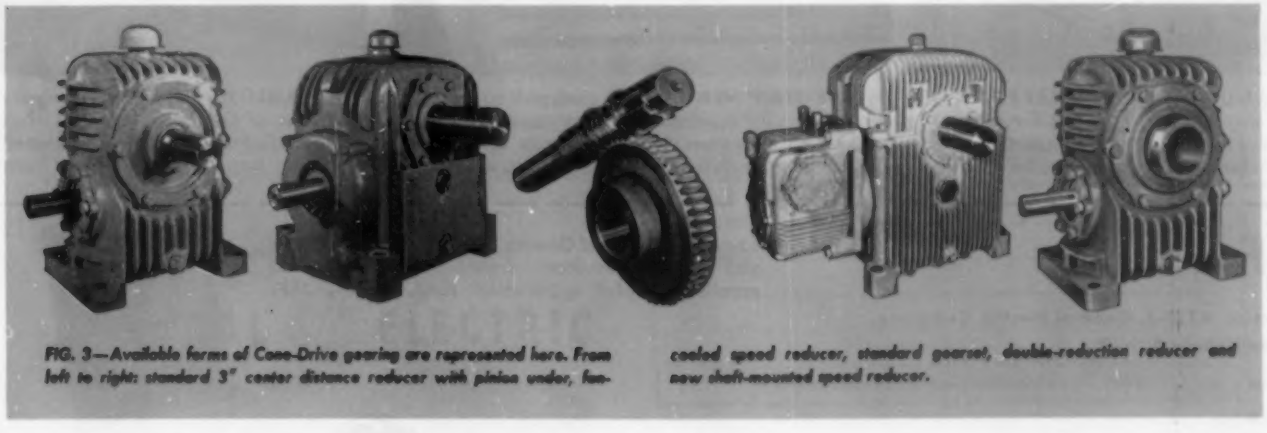
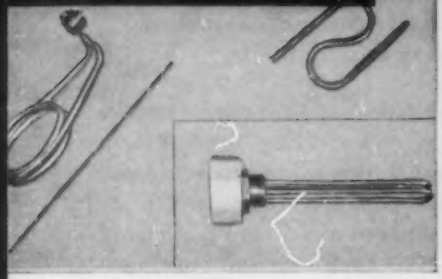


FIG. 3—Available forms of Cone-Drive gearing are represented here. From left to right: standard 3" center distance reducer with pinion under, fan-cooled speed reducer, standard gearset, double-reduction reducer and new shaft-mounted speed reducer.

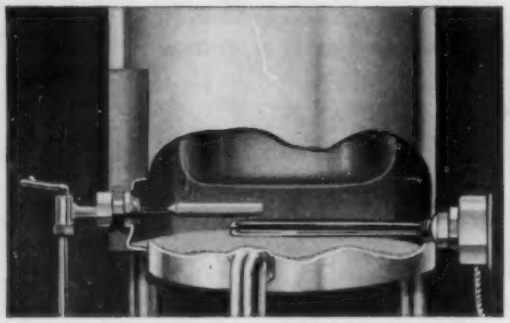
DESIGNING HEAT INTO YOUR PRODUCT?

"1001" G-E Calrod* Heaters Give You Design Freedom Plus Easy Installation

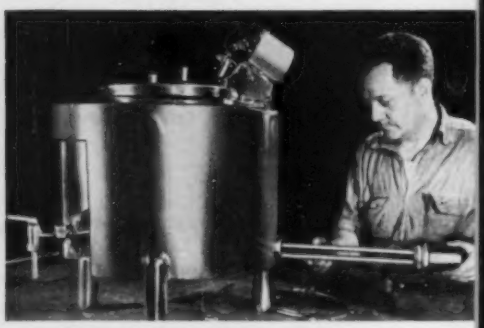
HEATING LIQUIDS



1 **GENERAL ELECTRIC** "screw-in" type heater is selected from wide variety of G-E immersion heaters by manufacturer of milk pasteurizers.

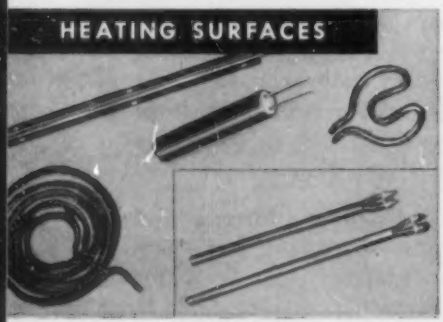


2 **EASILY INSTALLED** General Electric Calrod heater is inserted directly into side of pasteurizer. Immersion heaters provide maximum contact with water in jacket, minimizing heat loss.

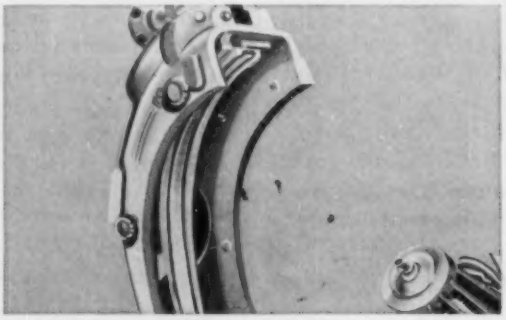


3 **DEPENDABLE SERVICE** is assured by sealed terminals, high-grade resistance wire used in G-E immersion heaters. Milk spoilage is reduced.

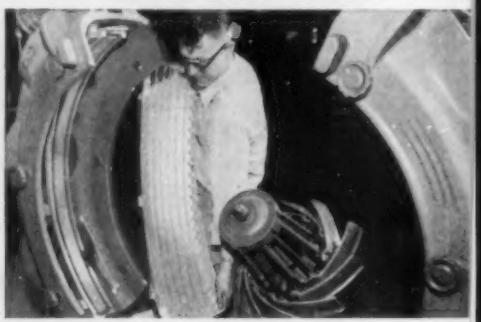
HEATING SURFACES



1 **FLEXIBLE BUT RUGGED** G-E tubular heaters are chosen by tire-retreader manufacturer after test. Other make heaters broke when formed.

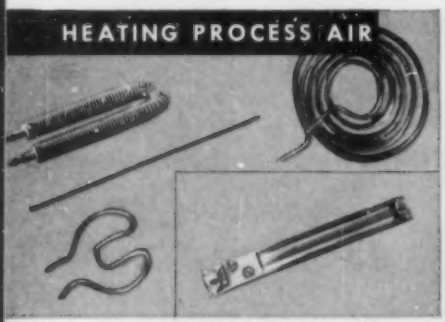


2 **GENERAL ELECTRIC CALROD** tubular heaters bend easily to the curved shape of tire retreader. Heaters are inserted into grooves in heating plate to gain maximum heat transfer.



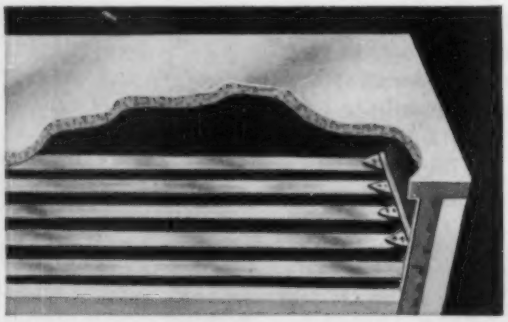
3 **EXACT HEAT** required for top-quality retreading of huge truck tires is achieved with high-efficiency General Electric Calrod heaters.

HEATING PROCESS AIR



1 **MANUFACTURER PREFERS** G-E "clamp-on" strip heaters for his high-temperature ovens. Versatile G-E tubular heaters could also be used.

*Registered trade-mark of General Electric Co.



2 **G-E STRIP HEATERS** are clamped to bottom of oven for maximum air movement. If a high degree of temperature uniformity is required heaters are clamped to top, bottom, and sides.

3 **FLEXIBLE PATTERN** and easy installation of G-E strip heaters reduces manufacturing costs—increases efficiency, improves saleability of ovens.

FREE

60-page Catalog of General Electric Calrod heaters and heating devices—describes full line. Also provides helpful application data. GEC-1005F.

Section A723-5, General Electric Company,
Schenectady 5, N. Y.

Name .....

Company .....

Street .....

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GENERAL ELECTRIC

Now—for the first time—

SILICONES THAT LUBRICATE

G-E Versilube fluid and grease work from −100 to +450 degrees F!

General Electric Versilube fluid and grease offer industry a new class of lubricants for applications subject to extreme temperatures. A G-E silicone "first"—*silicones with true lubricating properties*—they make possible an operating range of −100 to +450 F and are applicable to most metal combinations, including steel-on-steel. Product planners will find them the key to developing new designs. Plant engineers will appreciate their usefulness in maintaining the reliability and increasing the performance of present lubricating systems where extreme heat or cold are important factors.

Where can you use G-E Versilube fluid and grease?

Now available in commercial quantities, these new silicone lubricants are finding many applications where conventional oils and greases lack sufficient thermal stability. Potential uses include sleeve-bearing motors, jet engines, ball-bearing systems, and a multitude of lubricating jobs in such "hot" industries as steel, glass, and ceramics. Where can *you* use them? *Send coupon for more details!*

G-E silicones fit in your future

GENERAL ELECTRIC

CLIP AND MAIL TODAY!

Silicone Products Department
General Electric Company
Section 50-1B
Waterford, New York

Please send me product and application data on:

☐ G-E Versilube F-50 (fluid) ☐ Include Sample
☐ G-E Versilube G-300 (grease) ☐ Include Sample

Name_____

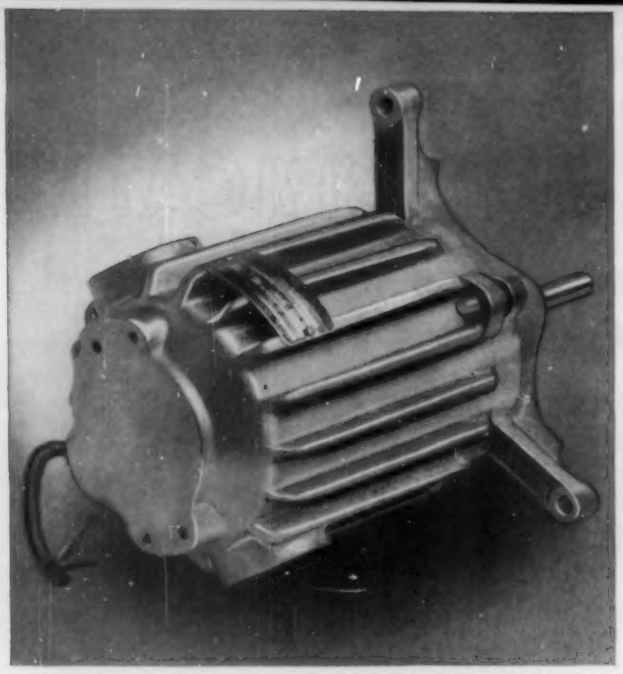
Position_____

Firm_____

Street_____

City_____ Zone____ State_____

IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto



1. UNIVERSAL MOTOR FOR BLOWER MEETS LIMITED SPACE REQUIREMENTS

General Electric engineers were asked to supply a specially mounted motor for an axial fan. Among the special considerations were a limited amount of space for the motor and need for exceptionally long brush life.

The space problem was solved by G-E engineers with a universal motor designed with a special tripod mounting, extended bearing nose, and a diameter of only $6\frac{5}{16}$ inches. Extensive testing proved this motor to have more than required brush life. This General Electric air-over motor can also be supplied in Class 1, Group D, explosion-proof construction.

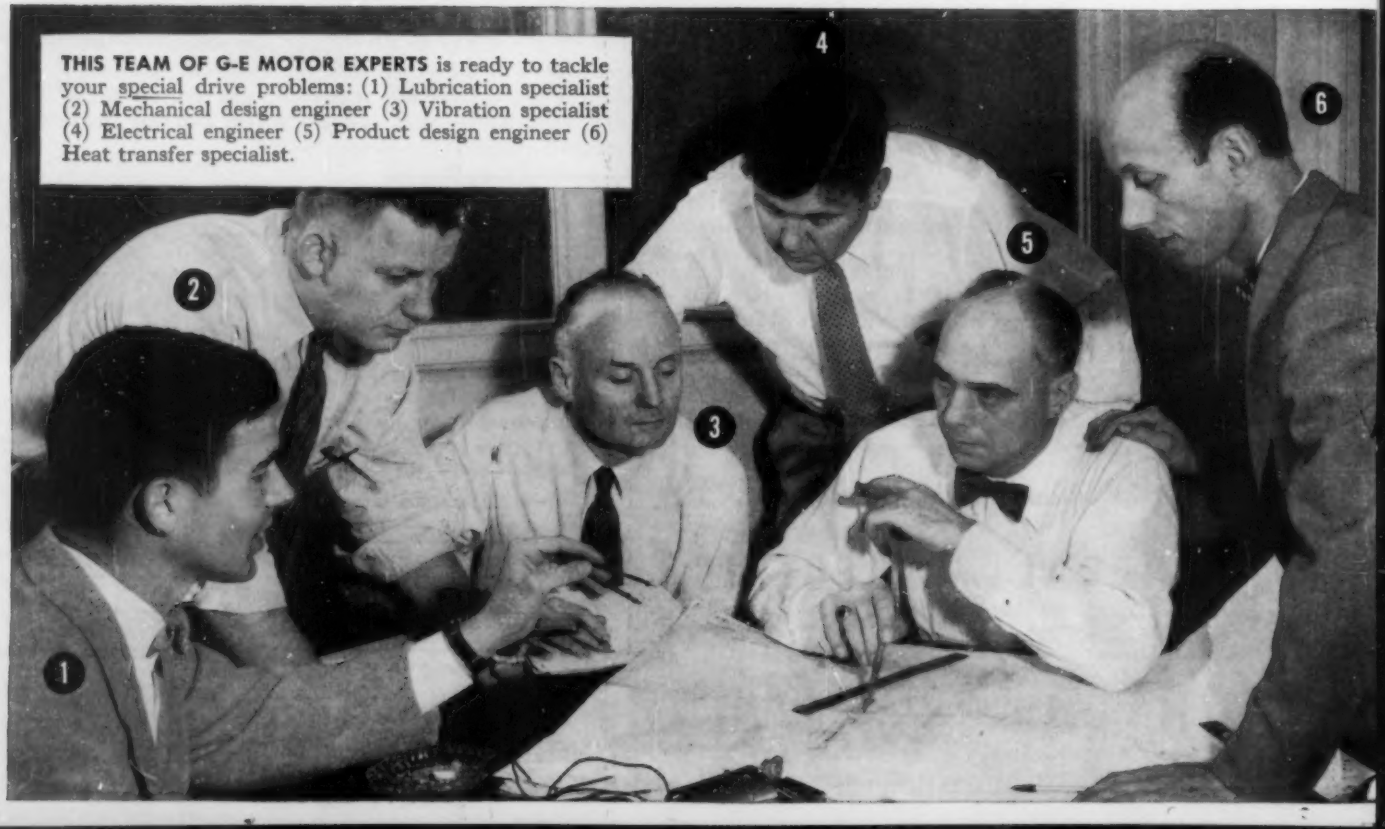
2. SPECIAL DC BRAKE MOTOR DESIGNED FOR LOCOMOTIVE DOOR OPENER

Limited space requirements presented a problem to G-E engineers when they were asked to design and build a motor to open and close a 1200-pound locomotive car door. Another specification: positive starting and stopping action.

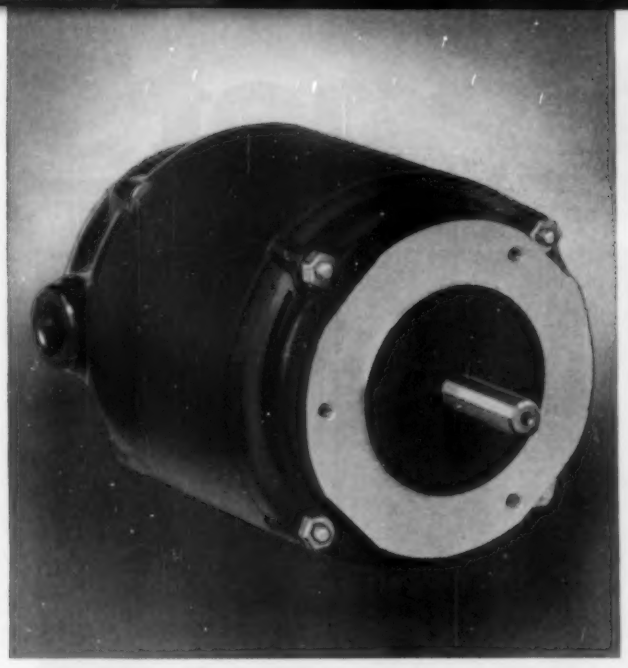
A team of General Electric motor experts designed a special space-conserving, side-wall mounted motor to be used with a gear reducer and magnetic brake.

G.E. offers a complete line of d-c motors in the following enclosures: drip-proof, totally enclosed non-ventilated, explosion-proof, severe-duty, navy- and marine-type construction.

These four cases show how you



THIS TEAM OF G-E MOTOR EXPERTS is ready to tackle your special drive problems: (1) Lubrication specialist (2) Mechanical design engineer (3) Vibration specialist (4) Electrical engineer (5) Product design engineer (6) Heat transfer specialist.

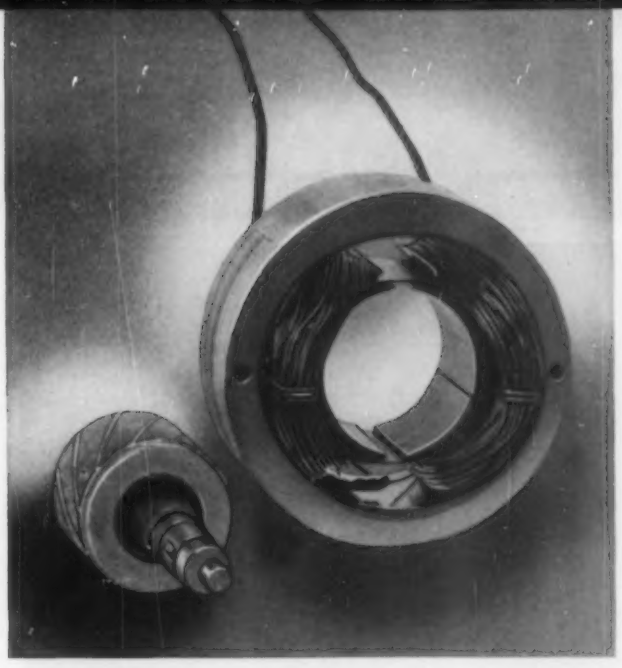


3. SYNCHRONOUS INDUCTOR MOTOR IDEAL FOR LOW-SPEED CAMERA DRIVE

This General Electric customer required a special low-speed motor for an automatic camera drive. Among the customer's specifications was precise starting and stopping action.

Experience indicated that a synchronous inductor motor would be ideal for this low-speed application. The synchronous inductor motor G-E engineers came up with had a rabbet fit for direct mounting to the camera. The motor operates at 75 rpm and a torque of 75 oz-in., and is giving excellent service.

Synchronous inductor motors—a G-E exclusive—are available in 115- and 230-volt ratings 60, 50, and 25 cycles.



4. SHADED-POLE INDUCTION MOTOR TAILORED TO VIBRATING SANDER

An industrial sander manufacturer requested a built-in motor to withstand severe vibrations.

G-E engineers, working closely with customer engineers, helped to develop a hand sander, cool to the touch, by adapting a specially designed shaded-pole motor rotor and stator.

Not only were these shaded-pole motor parts designed to withstand vibrations encountered in application, they also allowed the customer to greatly simplify assembly operations.

G-E shaded-pole motor parts are available in ratings from 15 mhp to 1/12 hp, 115 and 230 volts, 60 and 50 cycle.

solve drive problems when you buy General Electric specialty motors

You buy solutions to your electric drive problems when you buy versatile General Electric specialty motors. These motors, applied by experienced G-E application engineers, can really solve the "tough ones" for you—design problems like those posed above.

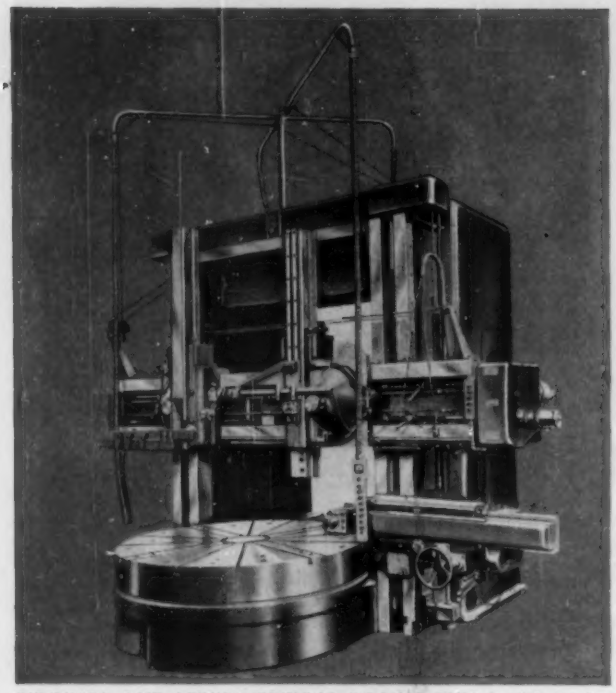
Among the specialty motor products available for your application are: d-c motors and generators, shaded-pole motors, specialty induction motors, amplidynes, tachometer generators, low-speed synchronous inductor motors, dynamotors, and universal motors and parts.

TURN OVER YOUR SPECIAL MOTOR PROBLEMS to General Electric early in your planning by contacting your local G-E Apparatus Sales Office. Or, if you prefer write describing your requirements including quantity and application to Section 704-54, General Electric Company, Schenectady 5, N. Y.

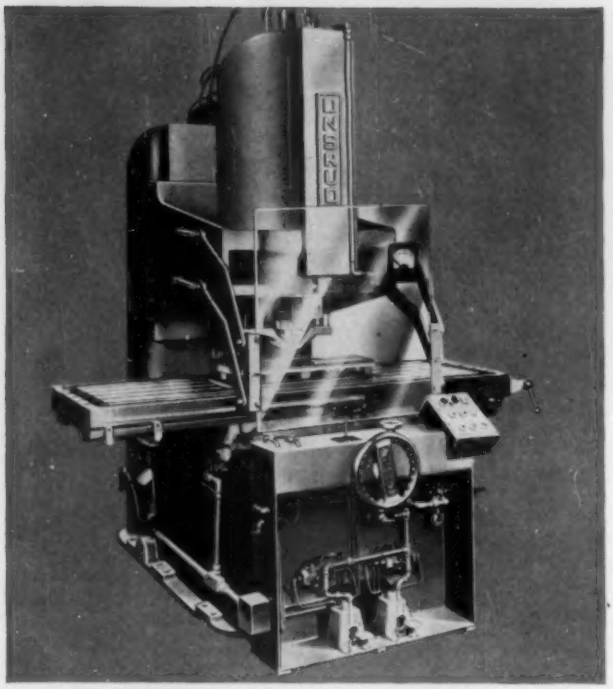
Progress Is Our Most Important Product

GENERAL ELECTRIC

Designer's

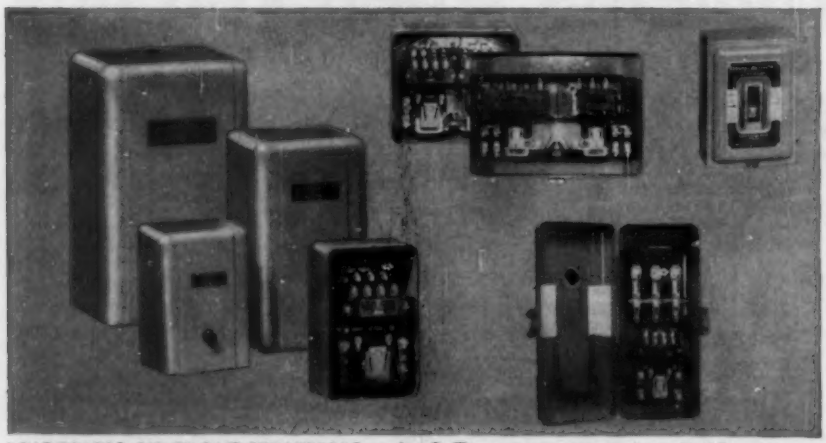


GIDDINGS AND LEWIS VERTICAL BORING MILL is driven by G-E direct-current motors, utilizes G-E all-electric tracer control for fast, accurate production. Control automatically follows templates, controls any number of motions.

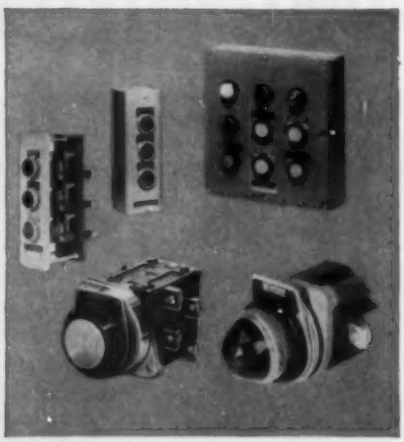


ONSRUD MACHINE WORKS INC. A-42 INVOMILL for high-speed, nonferrous metal milling, profiling and routing uses three electronic amplidyne feed drives. General Electric devices control longitudinal, transverse and circular motions.

SEE THESE G-E DEVICES, BOOTHS 107, 108, 109



SOLDERLESS, UP-FRONT TERMINALS make G-E starters easy to install. Many types are available including combination, reversing, multispeed, and manual and magnetic for full- or reduced-voltage starting. They feature G-E strongbox magnet coil, enclosed in a tough molded plastic case for better protection against dirt, oil and moisture; special alloy contacts for long life; and permanent air gap that can't wear down. All popular NEMA and special enclosures are in the General Electric line.

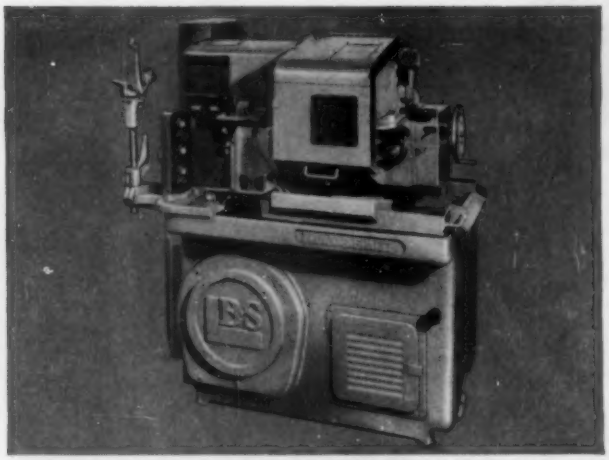


COMPLETE LINE includes standard, heavy-duty, and oiltight push buttons. Stations are made in all NEMA type enclosures. "Building-block" flexibility of the oil-tight line permits any combination of units in 1–16-unit stations.

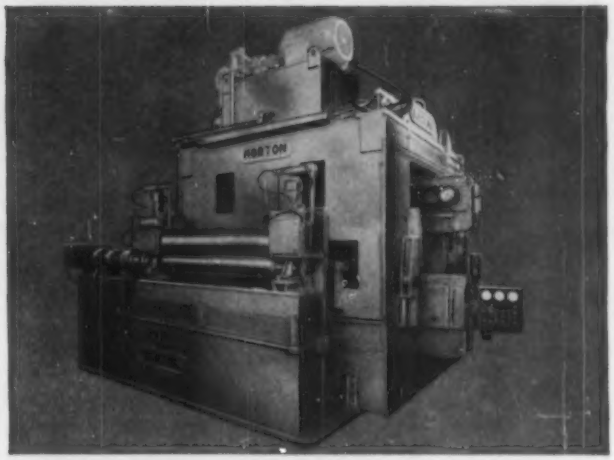
GENERAL ELECTRIC

Digest

SHOW ISSUE FEATURING EXHIBITS AT THE MACHINE TOOL SHOW



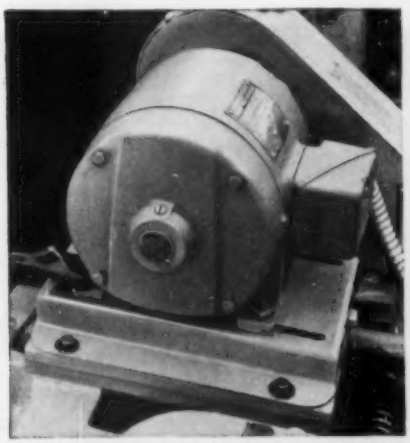
BROWN AND SHARPE AUTOMATIC SCREW MACHINE, compactly designed to occupy little space, is equipped with General Electric Tri-Clad* motors, General Electric magnetic switches, relays, capacitors and push-button stations.



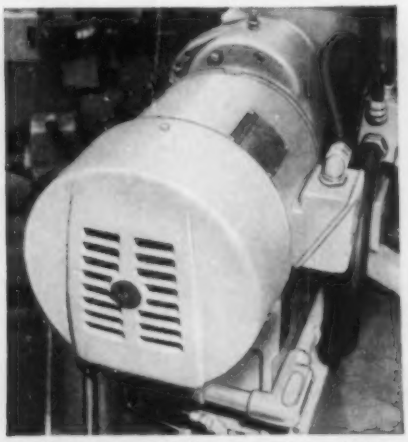
MORTON SHEAR-WELD-TRIMMER, operated by G-E motors, is controlled by a General Electric motor control center, which features extra large wiring trough, vertical bus barrier, easily removable starter units, and front connection.

Wide range of G-E components will help new machine tools increase production

PRODUCTION ENGINEERING SHOW



MORE HORSEPOWER IN LESS SPACE makes G-E Tri-Clad* '55' motors ideal for machine-tool applications. (Dripproof motor above.) General Electric's new design permits weight reduction up to 33% in some ratings, size cuts up to 40%. Installed on the newest machine tools, Tri-Clad motors give a neat, compact, modern appearance. Available in a wide range of ratings and enclosures, they're easy to handle, easy to install, and reduce shipping and handling costs of your product.



LONGER MOTOR LIFE is engineered into each Tri-Clad '55' motor. (Totally enclosed fan-cooled motor above.) Cast-iron frame, new cooling and insulation systems, and fully sealed conduit box mean long, reliable service in even the most adverse conditions—abrasive or conductive dusts, or where coolant is present. These features are prompting the big "motor switchover" in which 80% of G-E motors sold in the ratings in which Tri-Clad '55' motors are available, are built to these specifications.

By 1964 the estimated demand for goods and services from all industry will increase 40%. The available work force, however, will increase only 13%. To provide for industry's future needs, therefore, tomorrow's machine tools must be faster, more efficient, and more automatic in operation.

Setting the pace are progressive manufacturers exhibiting these and other new machine tools at the Machine Tool Show. General Electric components help improve the tools' performance and raise output standards to meet or surpass predictions.

G.E. offers designers literally thousands of machine tool components, continually redesigned and improved in extensive development and research facilities that help make up G-E engineering leadership. A few of the new machine tools with G-E components exhibited at the show are described on these pages.

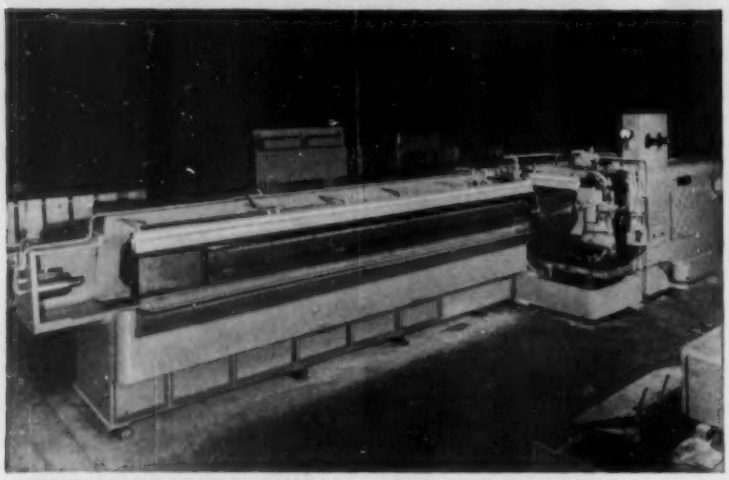
For further information, contact your nearest G-E Apparatus Sales Office, or write to Sect. 668-124, General Electric Company, Schenectady 5, N. Y.

*Reg. trade-mark of General Electric Co.

TURN PAGE FOR MORE SHOW ISSUE NEWS

Designer's

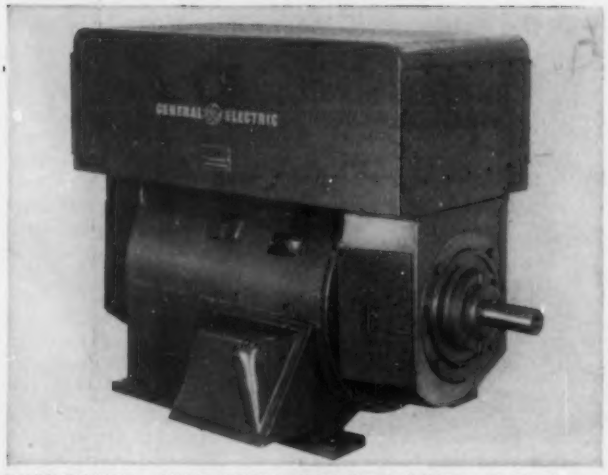
CONTINUED FROM PREVIOUS PAGE



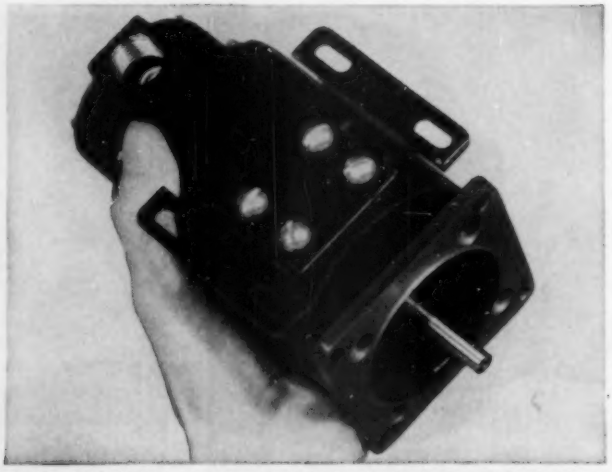
LAPOINTE HORIZONTAL SURFACE BROACHING MACHINE is designed with G-E broach drive including 50-hp d-c unit-cooled motor, 50-kw unit-cooled m-g set, exciter and control. It achieves speeds up to 300 fpm and more with smoothness and flexibility never before possible.

THIS CLEARING INCLINABLE 60-TON PRESS employs a G-E Tri-Clad ▶ motor, G-E control panel with G-E nonreversing starter, G-E control transformer, and G-E relays and oiltight push buttons. Unusually small control panel is easily accessible to the machine operator.

Designers of modern machine tools build in



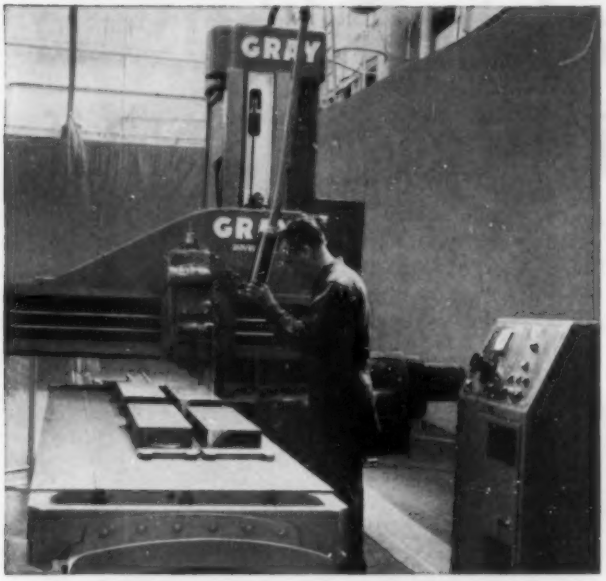
DUST-PROOF, COMPLETELY SELF-CONTAINED, G-E direct-current totally enclosed unit-cooled motor is especially suited for broaching machines like the LaPointe model above. These G-E unit-cooled d-c motors require no external duct work or air filters, yet provide your machines with dependable driving power even in severe atmospheres. Two independent air flow systems circulate air internally and externally, while an air-to-air heat exchanger, part of the unit cooler, dissipates heat losses. Standard units, ready for your designs, are available in all standard ratings from 15 to 200 hp, in constant or adjustable speed types.



NEW, SMALLER, LOW-COST TACHOMETER GENERATOR solves many speed measurement and control problems in machine-tool design. It occupies minimum space, can be flange- or foot-mounted, and installed horizontally or vertically. Its high versatility permits it to be direct-coupled, geared, or belt-driven, according to your needs. Two models are available. For use as a pilot exciter on many control applications and for speed indication, the high output-voltage unit of 100 volts per 1000 rpm is ideal. For speeds up to 5000 rpm a 50-volt per 100-rpm model is available. Both have a conduit box tapped for a 2½-inch connection.

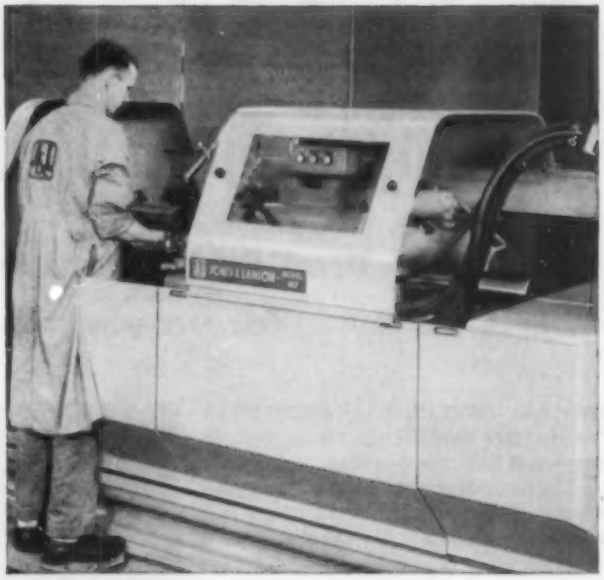
Digest

SHOW ISSUE FEATURING EXHIBITS AT THE MACHINE TOOL SHOW



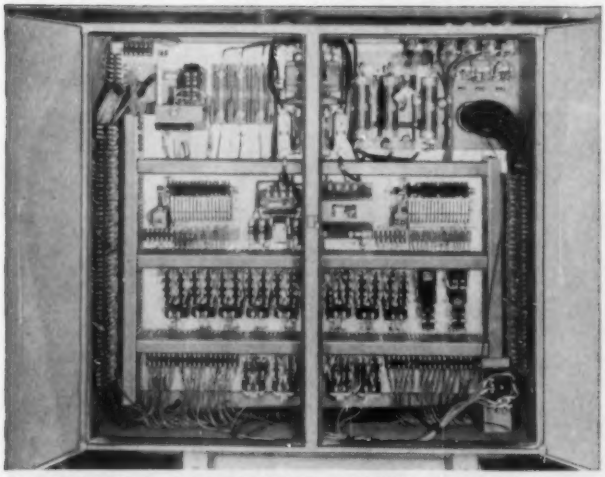
GRAY UNIVERSAL PLANER uses one G-E planer-drive system including an m-g set with exciter, main d-c drive motor, planer limit switch, tachometer generator, and three Tri-Clad* motors. Uniquely, it cuts on both forward ***and*** reverse stroke.

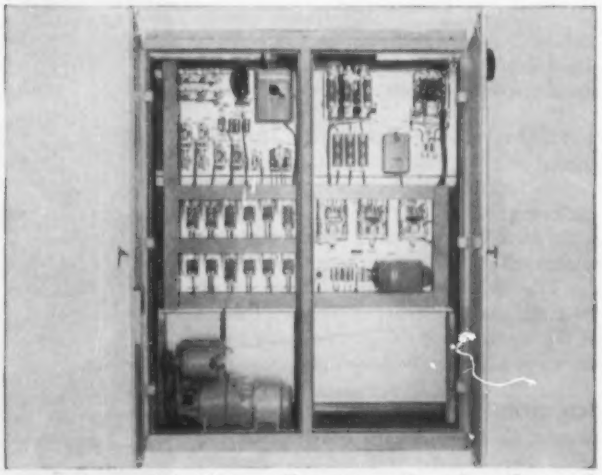
*Reg. trade-mark of General Electric Co.



JONES AND LAMSON AUTOMATIC LATHE, equipped with a custom-engineered G-E industry control panel, shown elsewhere on this page, is a four-cut, fully sequential, hydraulically-controlled lathe with a 45-degree tracing slide.

G-E components for quality and reliability





CUSTOM-BUILT G-E CONTROL PANELS are specially engineered for each application. The panel at left, for example, was built for the Jones and Lamson lathe shown at the top of the page. These panels save machine-tool designers time, effort and cost because General Electric designs and tests them for your specific needs. This reduces the load on your own design and drafting staffs, releases them for other projects. You save on inventory and storage costs of components, and eliminate assembly and wiring, cutting installation costs. General Electric's extensive service facilities include 37 Apparatus Service Shops offering 'round-the-clock service, easily reached by your customers everywhere. 668-125

GENERAL ELECTRIC

Designer's Digest

Flexible G-E Speed Variator Drives Save Machining Time, Provide Longer Tool Life

Provide constant surface cutting speeds for varying shape work pieces

GENERAL ELECTRIC PACKAGED SPEED VARIATORS can cut machining time as much as 47% when powering boring mills and lathes. They provide maximum constant surface cutting speeds for longer tool life, better surface finish and greater productivity.

LONGER TOOL LIFE—Carbide tools last longer if worked at the correct constant surface cutting speed. Speed Variators adjust spindle speeds automatically so work piece always travels by the tool at the same speed. As the tool approaches or moves away from the center of the work, a cam-operated reactor produces an electrical signal which is fed to the Speed Variator power unit. The Variator automatically adjusts the spindle speed to maintain the ideal cutting speed. Also, the operator can obtain a wide range of spindle speeds *without* gear changing.

FACTORY-TESTED COMPACT DRIVES consist of: (1) Power unit housing conversion equipment in small, ventilated enclosure; (2) Operator's control station, with push buttons and rheostat that mount where convenient for operator; (3) Direct-current drive motors, whose inherent characteristics of constant torque or horsepower and low inertia make them ideal for machine-tool operations.

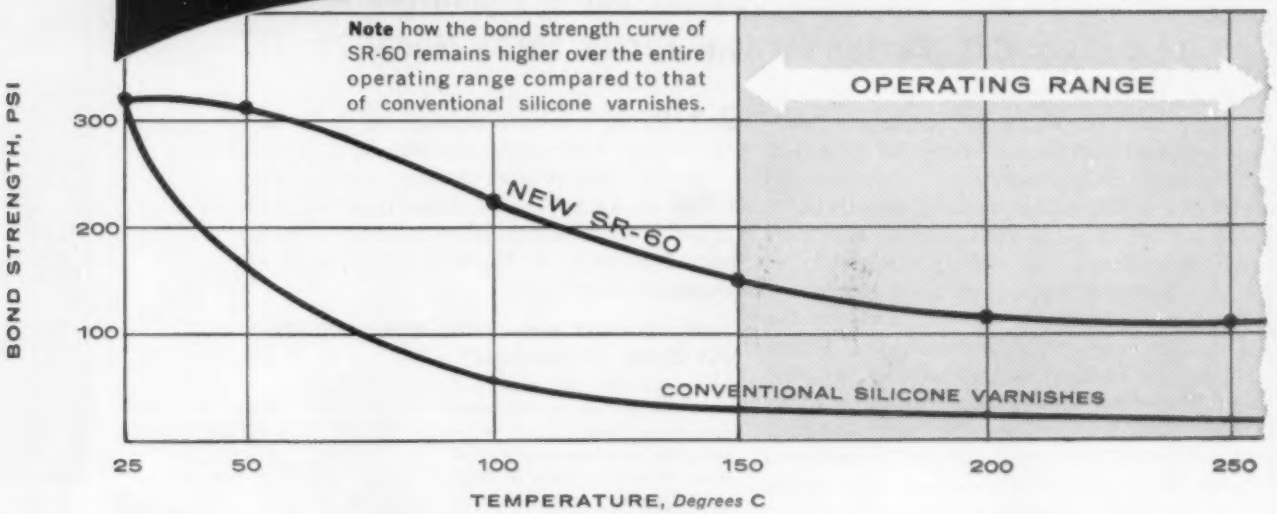
FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office, or write for bulletin GEA-6127. Section 815-1, Direct Current Motor and Generator Department, General Electric Co., Erie, Pa.

LONGER TOOL LIFE... Lathe, machining turbine wheels, gives better performance since G-E Speed Variators maintain constant surface cutting speeds within narrow limits.

GENERAL ELECTRIC

G.E.'s NEW SR-60

silicone impregnating varnish offers you **greatly improved bond strength** under operating conditions



General Electric's new SR-60 silicone impregnating varnish offers you up to *four times the bond strength,* at operating temperatures, of conventional silicone varnishes tested. Developed to provide improved performance at temperatures of 250 C and higher, it offers many other advantages over existing materials. For example, SR-60 cures at 150 C! Its viscosity is low, providing good penetration; yet it has excellent film-building properties. Resistance to oils is superior to other silicones and there's lower weight loss on heat-aging.

SR-60 represents the *first real improvement* in silicone impregnating varnishes in years. Not just a laboratory product, SR-60 is available in commercial quantities—proved by functional tests in the field!

CHECK THESE 6 BIG BENEFITS

- √ Up to 4 times more bond strength
- √ Cures at 150 C
- √ Excellent film build
- √ Lower weight loss on heat-aging
- √ Improved oil resistance
- √ Withstands 250 C and higher

G-E silicones fit in your future

GENERAL ELECTRIC

SEND FOR DETAILS—TODAY!

Silicone Products Department, General Electric Company
Section 53-4D, Waterford, New York

Please send me data and application sheets on SR-60.

Name_____

Position_____

Firm_____

Street_____

City_____

Zone_____ State_____

IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto

Why leading machine tool manufacturer specified G-E Flamenol wire

95-conductor G-E Flamenol control cable simplifies wiring of Bullard Cut Master Vertical Turret Lathe Model 75

Engineers of the Bullard Company, a leading machine tool manufacturer, selected G-E Flamenol* control cables and machine tool wiring for this giant vertical turret lathe. One of the reasons was General Electric's ability to design and supply the variety of cables that best fitted their product needs—like the 95-conductor control cable for the Cut Master Vertical Turret Lathe. Other points that Bullard engineers found valuable were the color coding that simplified circuit wiring and tracing, and the easy stripping of individual conductors which helped them make the hundreds of necessary connections and terminations quickly and easily.

Other important advantages of G-E Flamenol wiring are its resistance to flame and corrosion, high dielectric strength, small diameter, and its smooth, hard, surface that needs no overall protective finish such as braid or lead. Meets Joint Industry Conference Standards of National Machine Tool Builders Association.

CAN G-E WIRES AND CORDS GIVE YOUR PRODUCT EXTRA ADVANTAGES?

Investigate how G-E wires and cords can become an important part of your product story. Write today for your free copy of "G-E Wires, Cables, and Cords for Product Designers." Address Section W166-967, General Electric Company, Bridgeport 2, Connecticut.

THERE'S A COMPREHENSIVE LINE OF G-E WIRES AND CORDS FOR YOUR PRODUCT WIRING REQUIREMENTS.

G-E CORDS

General Electric flexible cords provide outstanding performance and long life in service where resistance to heat, moisture, acids, alkalies, water, grease, oil, or similar conditions is imperative. The product designer will find a wide selection available for practically every type of electrical appliance and industrial equipment.

G-E MAGNET WIRE

General Electric has the correct type for every requirement.

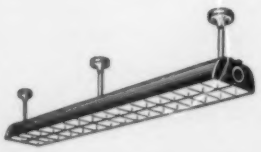
For Class A Applications — (Temperatures up to 105 C)—Formex* synthetic resin film-insulated wire.

For Class B Applications—(Temperatures up to 150 C)—General Electric Alkanex† magnet wire, Deltabeston* glass, or asbestos-insulated types.

For Class H Applications—(Temperatures up to 180 C)—General Electric glass or asbestos types impregnated with silicone varnishes, and Teflon** film-insulated magnet wire.

G-E FIXTURE WIRE

General Electric fixture wire is available with asbestos, silicone rubber, or thermoplastic insulation to meet a wide variety of lighting fixture needs.



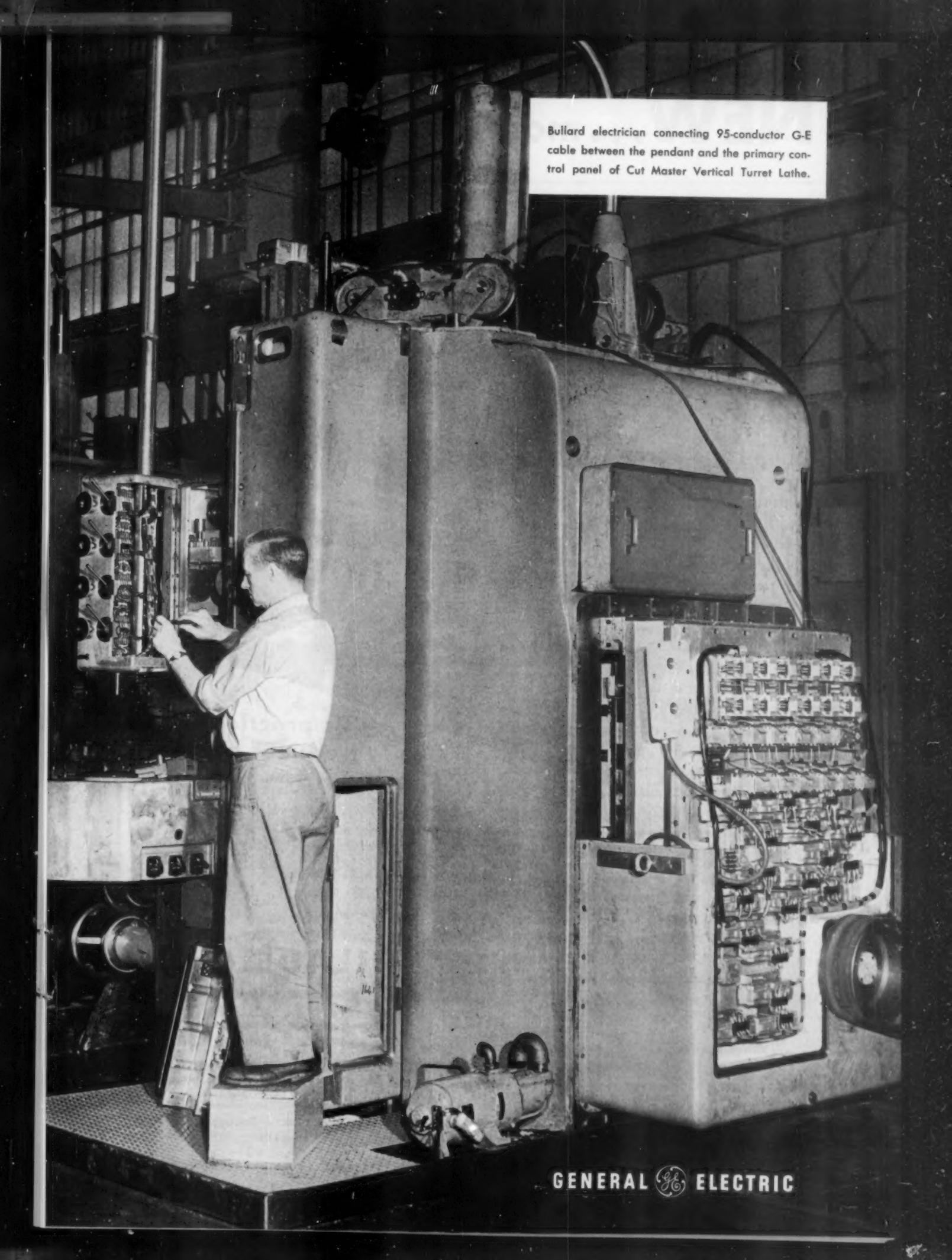
** Registered Trade-mark General Electric Company*

† Trade-mark registration applied for by General Electric Company

*** DuPont Trade-mark for tetrafluorethylene resin*

Progress Is Our Most Important Product

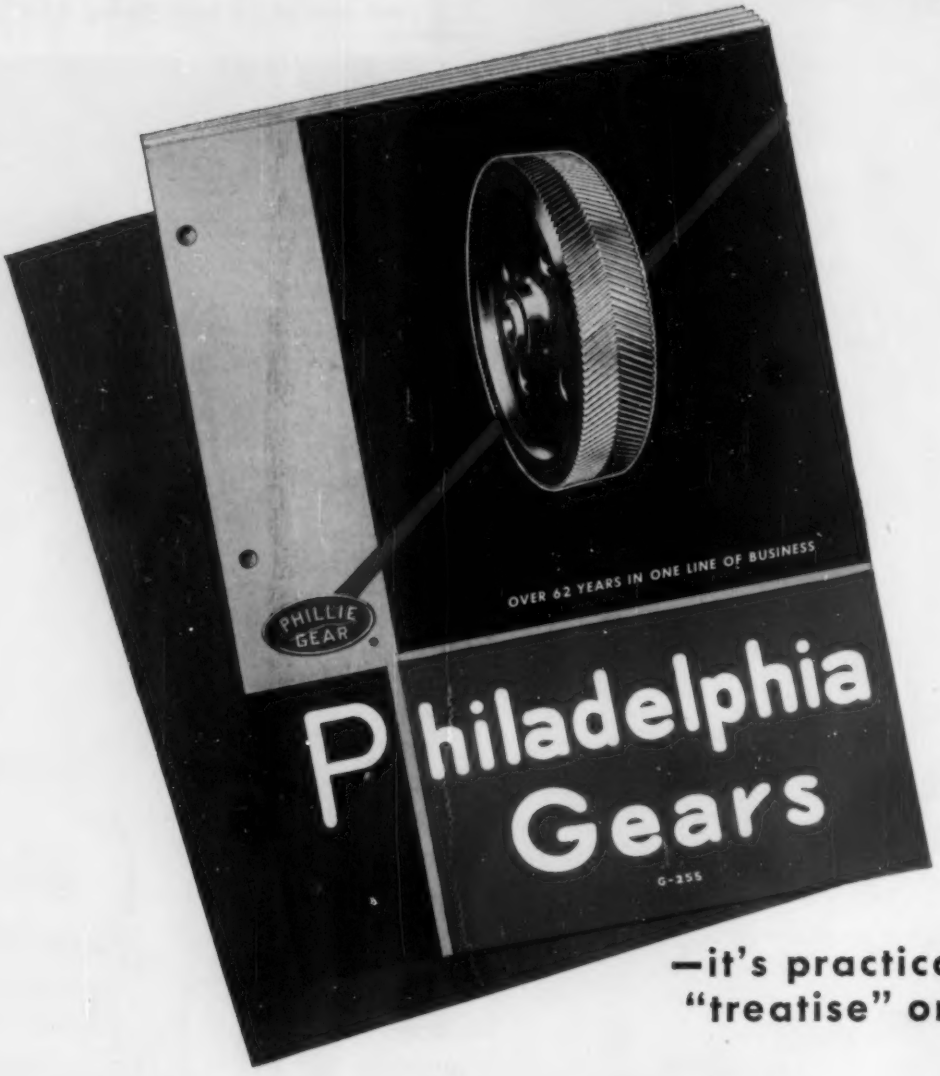
GENERAL ELECTRIC



Bullard electrician connecting 95-conductor G-E cable between the pendant and the primary control panel of Cut Master Vertical Turret Lathe.

GENERAL ELECTRIC

NEW... *more than a catalog—*



—it's practically a "treatise" on gears

Never before, to the best of our knowledge, has so much helpful information been assembled between the covers of a gear *catalog* . . . 76 pages of illustrations, diagrams, definitions, tables, charts, and explanations regarding all types of gears. If you design, use or buy gears, you can't afford to be without a copy of this Book—so fill in coupon below for your copy of this valuable text.

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Virginia Gear & Machine Corp., Lynchburg, Va.

Industrial Gears & Speed Reducers • LimiTorque Valve Controls

Established 1892

Perspectives

IN DESIGN AND DEVELOPMENT

COPPER

As of this writing, one of the tightest supply conditions in years exists in the domestic copper situation, with an already short supply being aggravated by striking smelter workers. This situation is reducing anticipated supplies by about 12,000 to 15,000 tons weekly. In addition, this amount is about the quota to the stockpile—16,000 tons—for third quarter copper deliveries, which has already been deferred. Although they do not want to do anything so drastic, officials in the Office of Defense Mobilization have talked of cutting civilian priority schedules during the emergency. This has not been done since the Korean War.

The scarcity of copper has stopped operations in many small plants, and it is expected to get worse. Tight copper scrap export controls have already been put into effect, and more severe controls may follow. An actual removal of stockpile copper by presidential order is the only way to alleviate the critical consumption requirements now, but the chances are that this probably will not be done. It has never been done with any metal. Chile's copper has not helped much. In 1952, the U. S. was getting 80 per cent of Chile's production. It has been cut down each year since, until now the U. S. can get no more than 33 per cent. The rest is going to Europe where copper is commanding 47 cents per pound. The best U. S. price is about 36 cents.

The only bright spot on the horizon is that one company (Phelps Dodge Corp.) has just announced that they have come to terms with the smelter workers union. But even if the others follow suit shortly, there is no hope of reaching a balance of supply and demand by the end of the year.

ALUMINUM

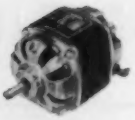
Total aluminum stockpile diversions of about 400,000,000 pounds have been added to the available supply for civilian demand. With some type of an Office of Defense Mobilization and General Services Administration set up for its re-allocation, the immediate shortage may be eased over. Congressional investigating committees checked the recent shortage and decided that the situation was the result of unfortunate circumstances, sudden heavy demand, low inventories, and stable production.

Meanwhile, there is still a possibility of an ODM-sponsored third round aluminum expansion. So far, Olin-Mathieson, Harvey, St. Joseph Lead, and Revere Copper & Brass all plan to build primary producing plants if the conditions are right, i.e., guaranteed loans, or markets.

Anaconda's first production hit the market last month, with more to follow by the first of 1956. The big three—Kaiser, Reynolds, and Alcoa are expanding, as well as Alcan, the big Canadian producer. Alcoa, just announced that as a result of recent wage increases, the price of 99 per cent minimum average aluminum pig will be increased one cent per pound, while 99 per cent plus aluminum ingot was upped by 1.2 cents per pound. The other two companies are expected to follow suit.

(Continued on page 125)

Why Bodine motors are used by these 3 leading office machine manufacturers



Victor Adding Machine Company

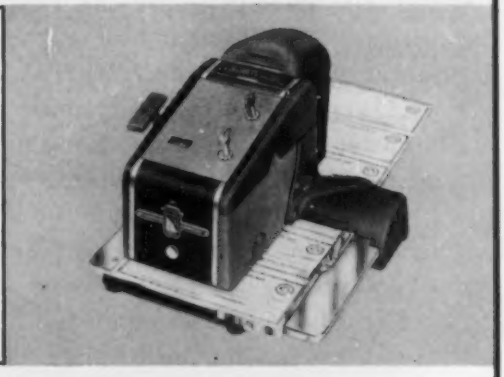
1

"The wear and tear of 16,400,705 machine operations during the exacting performance test failed to break down a Bodine motor."

The Hedman Company

2

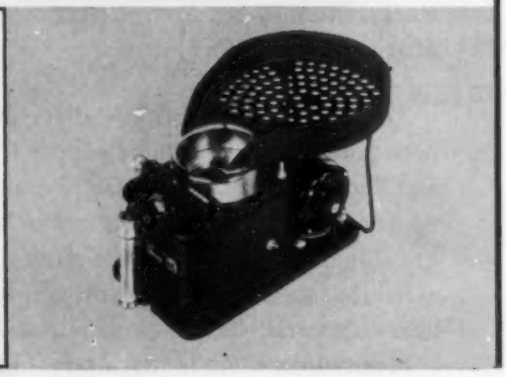
"For over 33 years we have used Bodine motors. We require motors that are small, sturdy, long lasting, quiet, trouble-free and have a high torque."



Klopp Engineering Company

3

"Since 1936 we have not had a single motor failure on this unit, which is certainly the reason that we are continuing to use your motor."



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sound recorders
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respirators
voltage regulators
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traffic signal timers
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calculating machines
envelope sealers
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Perspectives

STEEL

The backbone of the industry, steel, is still in tight supply, but is not critical. The metal is not stockpiled, and smelters have been running above 90 per cent production for months, since demands from the automotive industry have remained so high. But with retooling this fall for the 1956 models, steel demand will decline slightly. Even so, steel producers say that shipments are still far behind, and the mill backlogs have increased because of general good business. Flat-rolled steel is in greatest demand. Even after the general steel price increase in July, the expected letdown did not materialize. It has been reported that some fabricators will get only 50 per cent of their requirements for certain structural steels in the fourth quarter.

A number of additional steel smelting plants have been proposed, and are in construction with ODM-approved tax write-offs.

LEAD & ZINC

Two relatively unwanted metals a few months ago, lead and zinc have done an about face, and producers are having difficulty in filling orders. Inventories have been down in some cases to a point where there has been talk of ending the General Service Administration—sponsored emergency buying program to support the market price.

A bill to extend the 200,000 ton lead and 300,000 ton zinc buying program by the government was favored by Congress at the end of the session. Chances are that the recent tightening in these two metals will end in the fall.

TITANIUM

The government is still committed to buy up to 22,500 tons of titanium each year, but because of a lack of good refining techniques, only a small portion of this is being used, and Air Force demands take most of that. A recent government report, based on studies made by the Minerals, Materials and Fuels subcommittee says that the many bad reports on the status of titanium are not true, and that the difficulties in handling the metal no longer exist. It also says that we will be caught short if the present sponge goal of 22,500 tons is not revised upwards. The original goal was 35,000 tons a year, but for some unexplained reason this was cut back.

MANGANESE

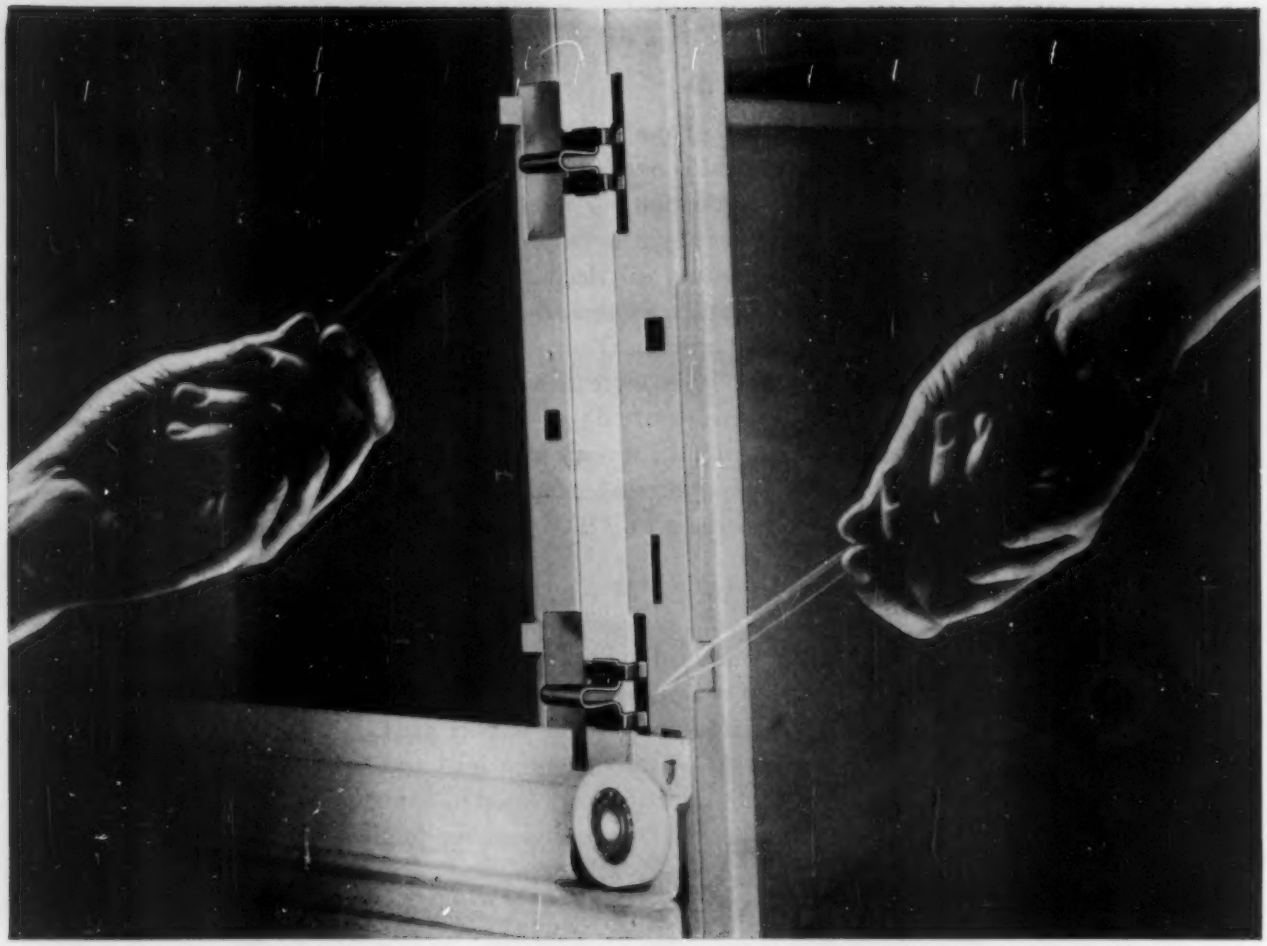
This metal is still under several large government sponsored research projects, with the hopes still high of developing an inexpensive, large quantity up-grading process for huge deposits. The steel demands have in turn kept the manganese demand high. A bill now in Congress would increase manganese buying programs by three times, and open two new depots.

NICKEL

Although not as bad as last spring, nickel is still in short supply. However, just recently the ODM directed that 500 tons of the material be made available from scheduled shipments to government stockpiles.

PLASTICS

Probable cutbacks in the auto industry will slow down plastics production somewhat, but prices will remain the same unless business generally slackens. Polyethylene is getting into many markets, and sales may reach 325-million pounds in 1955. New uses for the material should take up any surplus.



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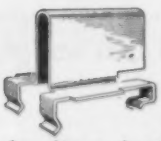

Here's the special SPEED CLIP that enabled the General Fireproofing Company, Youngstown, Ohio, to build maximum flexibility into its new "Generalaire" office furniture. A relatively small number of basic units can be interchanged to produce 46 different desk and table models. General Fireproofing reduces manufacturing and shipping costs; dealers have fewer parts to stock and handle!

This one-piece, spring-steel SPEED CLIP snaps easily and quickly into place by hand. It replaces a costly five-piece locking bar latch mechanism that had to be factory-installed in left- and right-hand assemblies. Now, SPEED CLIPS make it possible to ship knockdown locking bars to dealers who then build left- and right-hand assemblies from basic units to fill customers' orders. What's more, Generalaire desks are assembled throughout with 20 or more SPEED NUT brand fasteners which contribute greatly to this flexibility.

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Without Regard to the Past

WHOEVER HAS SEEN the amazing progress made in the reconstruction of bombed German cities cannot help but be greatly impressed. The ashes and ruins have been replaced by modernistic creations. These, for economic and sentimental reasons, would not now exist if destruction had not visited the land; for without the compelling forces of necessity, the courage to risk the capital would have been lacking. Also, being imbued with a tolerant satisfaction with things as they are, there was little desire to convert what was ancient into something modern, more useful, more satisfying, more efficient.

Old things are preserved and revered for several reasons, mostly sentimental. Man just hates to scrap what he has lived with no matter how low its value. That is why attics and cellars are so interesting. There are people who hold the lowly penny in high reverence. They hang on to their outmoded possession, be it ugly or useless, because they cannot forget the price their forefathers paid for the object. Only a fire, an earthquake, or other calamity can compel its victims to evaluate their lost possessions realistically. Even then too many hang on tenaciously to their worship of the relic that was.

The same philosophy or the same reverence for old things gives rise to a complacency that sometimes grips the thinking of an industrial organization, or perhaps only its engineering department. Somehow or other in the more or less dim past, the mind of some bright engineer gave birth to a wonderful idea that was patented and developed into a product which brought tremendous profit. The related profit became so important in the eyes of management and engineering that all effort was concentrated on further improving that patented device or product. Meanwhile, countless other opportunities to develop new products demanded by a changing economy passed by unseen.

Mr. Herman Heller of Gebrüder Heller Maschinenfabrik G. M. B. H. of Nürtingen, Germany, has a method of preventing any possibility of stagnation in product improvement being caused by the thinking of his engineers being concentrated on improving existing patents. Herr Doktor—Ing. Gunsser, director of product research and development at Heller explained the system in a minimum of words. "We do not patent our designs," he said, "Thereby we do not subconsciously concentrate our thinking on improving patented constructions. Instead, we continually reach out for entirely new and better designs. What we have done in the past is past. The creations of the future must be new without regard to the past."

Whether it be the rebuilding of a bombed city or the development of strikingly new products, the greatest progress can come only if the thinking and the planning is done without being restricted to the channels of the past.

George F. Goodenhott

NEW DEPARTURES OF TOMORROW

TOMORROW: Pick your favorite foods! Then this imaginary SUPER CHEF assembles your choice from a vast freezer storage, cooks it to perfection by infra-red ray and serves it by conveyor in a *matter of seconds!*

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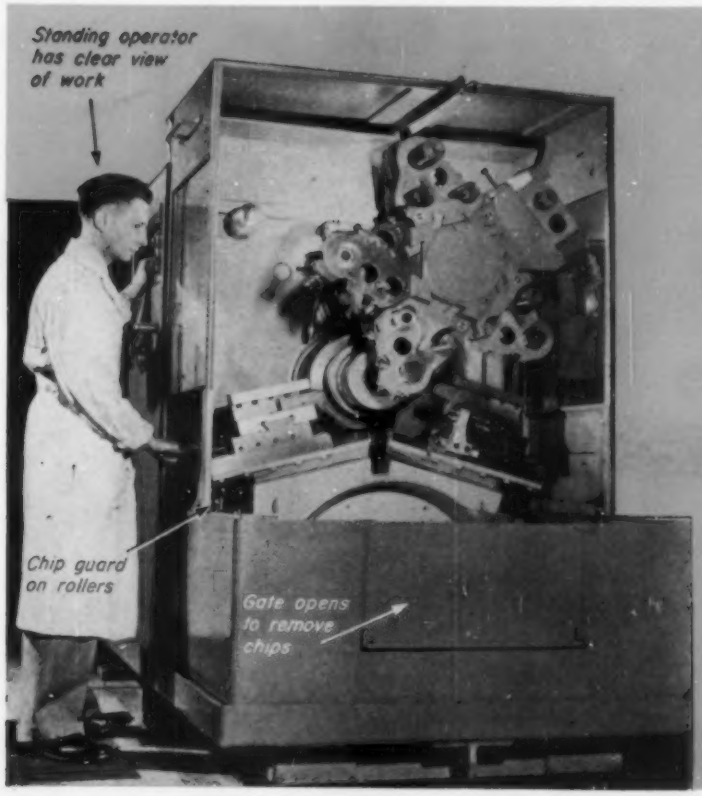
NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

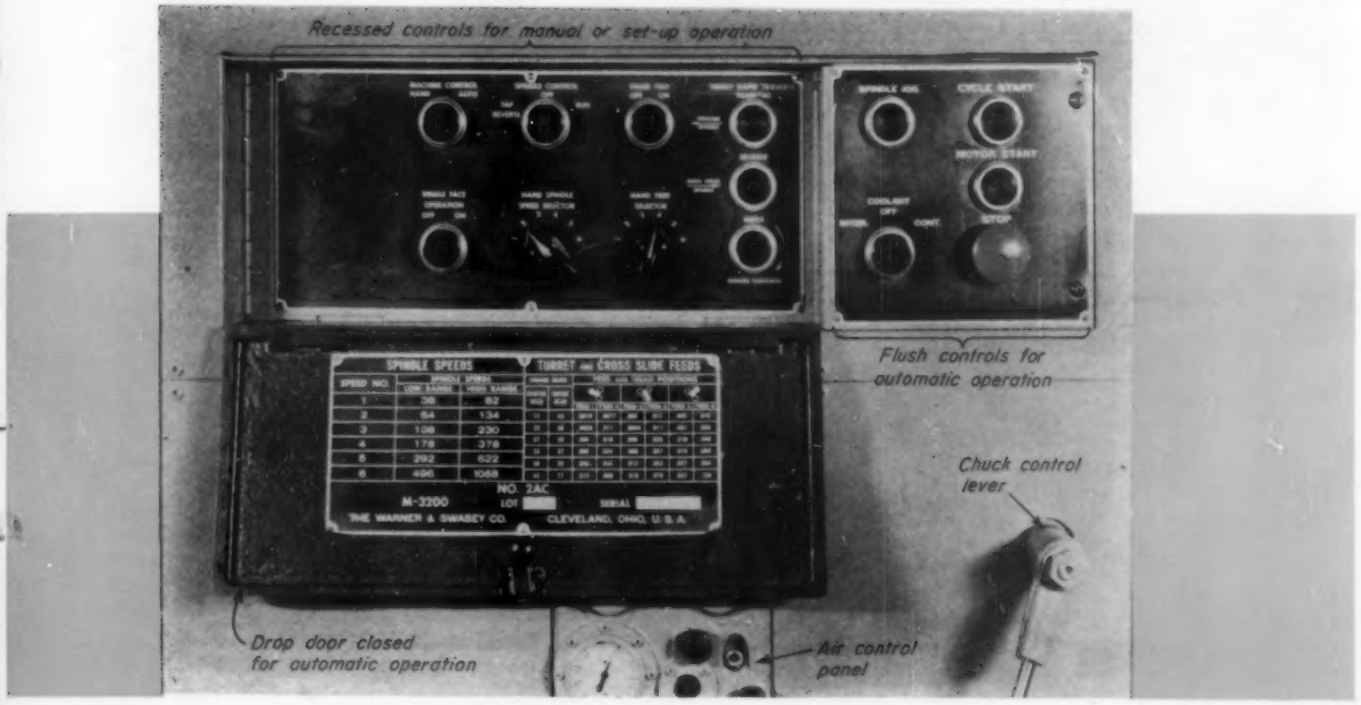


The tool turret is placed over the chuck and offset to the rear with three important advantages: chuck is more accessible for loading; with large work pieces the tools are closer to the ways; and chips and coolant fall clear of the work. Work and tools are in a better position for the operator to see what is going on.

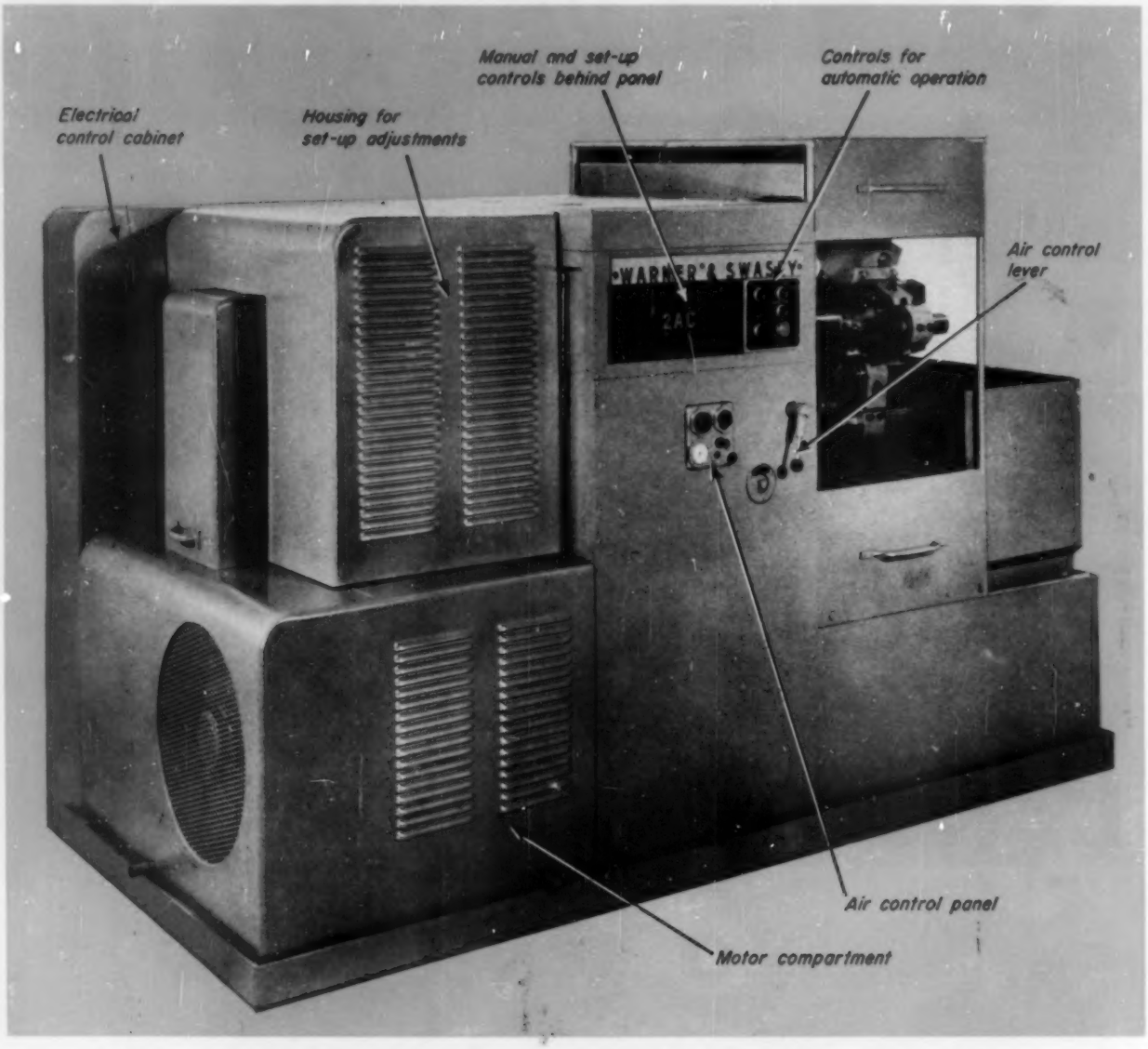
Vertical height of the operator control panel is within the optimum range between shoulder height and elbow height for the average man. (See article "Human Dimensions" in this issue, page 166; author of the article was consultant in design of this machine.) Because the controls had to be built into the head it was necessary to design them for left-hand operation; but this is a necessity if the operator's right hand is used to position work in the chuck.

Air chuck handle is designed for left-hand operation and is placed on level with the chuck so both hands are symmetrically placed for comfort. (Note: lever is being changed to a knob to reduce possibility of accidental operation during work cycle.)

(continued on next page)



Turret Lathe (continued)



All set-up adjustments are under the hood at the left end of the machine directly over the motor enclosure. Hood is spring counterbalanced for easy operation; when hood is lifted feed and speed selector switches, main control drum and index drum are out in the open at standing height. Main control drum (lower right, facing page) is integral with the turret bar and thus moves axially and indexes with the tools without intermediate linkages or gearing.

When motor enclosure is removed (center) main drive motor is accessible from all sides, coolant and indexing motors are exposed, and hydraulic motor, pump and filter are easily reached; oil pressure gage is at eye level. Flexible coupling in main motor drive is accessible for lubrication.

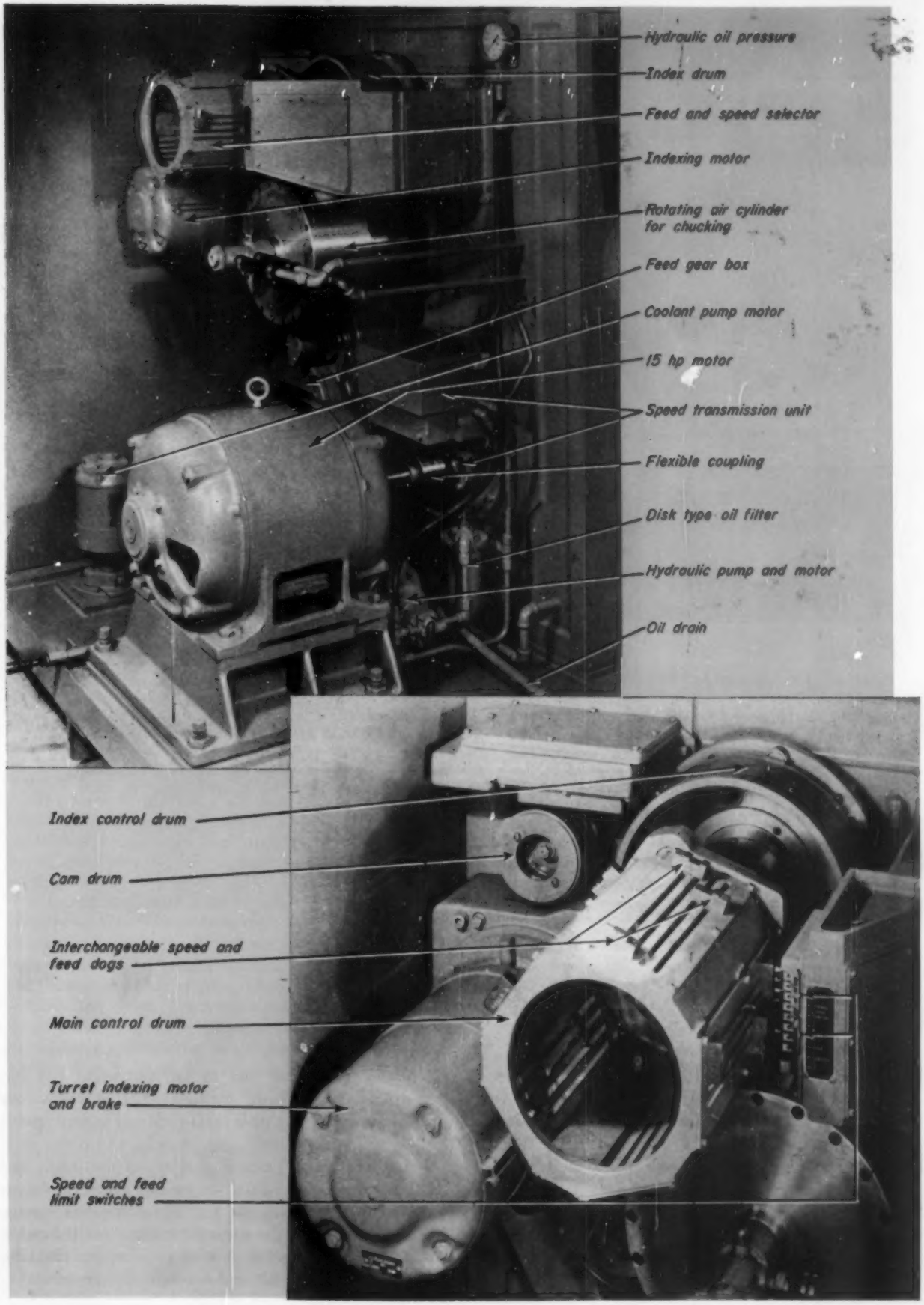
Work is held in an air chuck operated by the rotating air cylinder mounted on the rear of the spindle; this places the air gland grease fitting (upper right) in a fully accessible position. Air pressure to the cylinder is regulated by a control on the front panel, but an air switch (behind the coolant pump motor) permits operation of the machine only when line air pressure is over 45 psi.

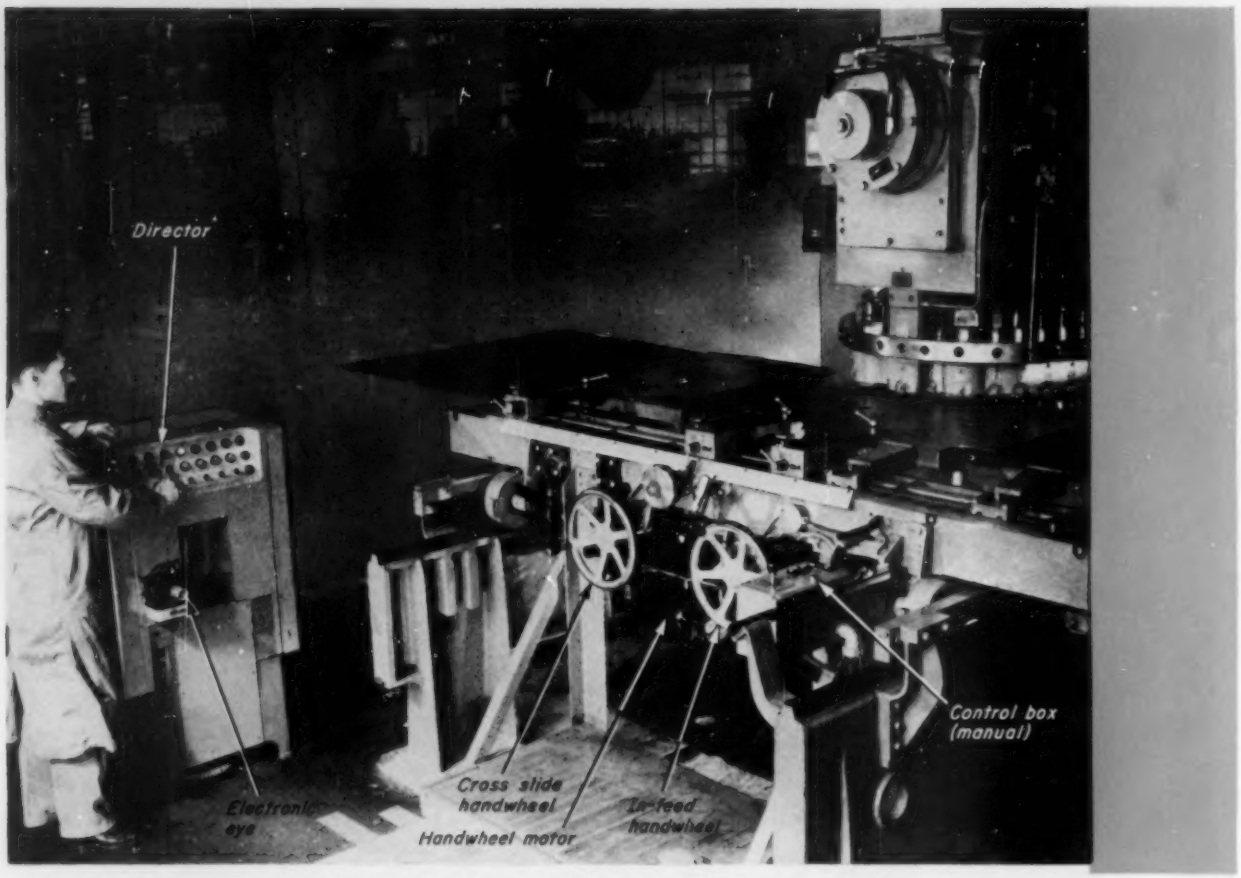
When necessary for servicing, unit design of power units permits independent removal of turret indexing drive, feed gear box and transmission, main speed transmission unit, and rapid traverse drive.

All set-up adjustments are made without tools (other than a socket wrench) and require no heavy muscular effort. There are no loose parts or nuts; for example, pick-off gears in feed gear box are retained simply by the gear box cover which is held in place by two captive bolts with large "handwheel" heads. When the cover is removed for access to change gears, power to the machine is automatically cut off, providing full safety to the operator.

Speed and feed dogs on the main control drum (see close-up at right) are adjustable from inside the drum with a socket wrench; lathe cross side operations are timed by the small cam drum to the left of the main control drum; cams are easily set clamped by a socket wrench of the same size. Cams trip electrical contacts to control feeds.

Control system is designed to permit selection of either or both cross slides with any or all turret faces.


Hydraulic oil pressure
Index drum
Feed and speed selector
Indexing motor
Rotating air cylinder for chucking
Feed gear box
Coolant pump motor
15 hp motor
Speed transmission unit
Flexible coupling
Disk type oil filter
Hydraulic pump and motor
Oil drain
Index control drum
Cam drum
Interchangeable speed and feed dogs
Main control drum
Turret indexing motor and brake
Speed and feed limit switches

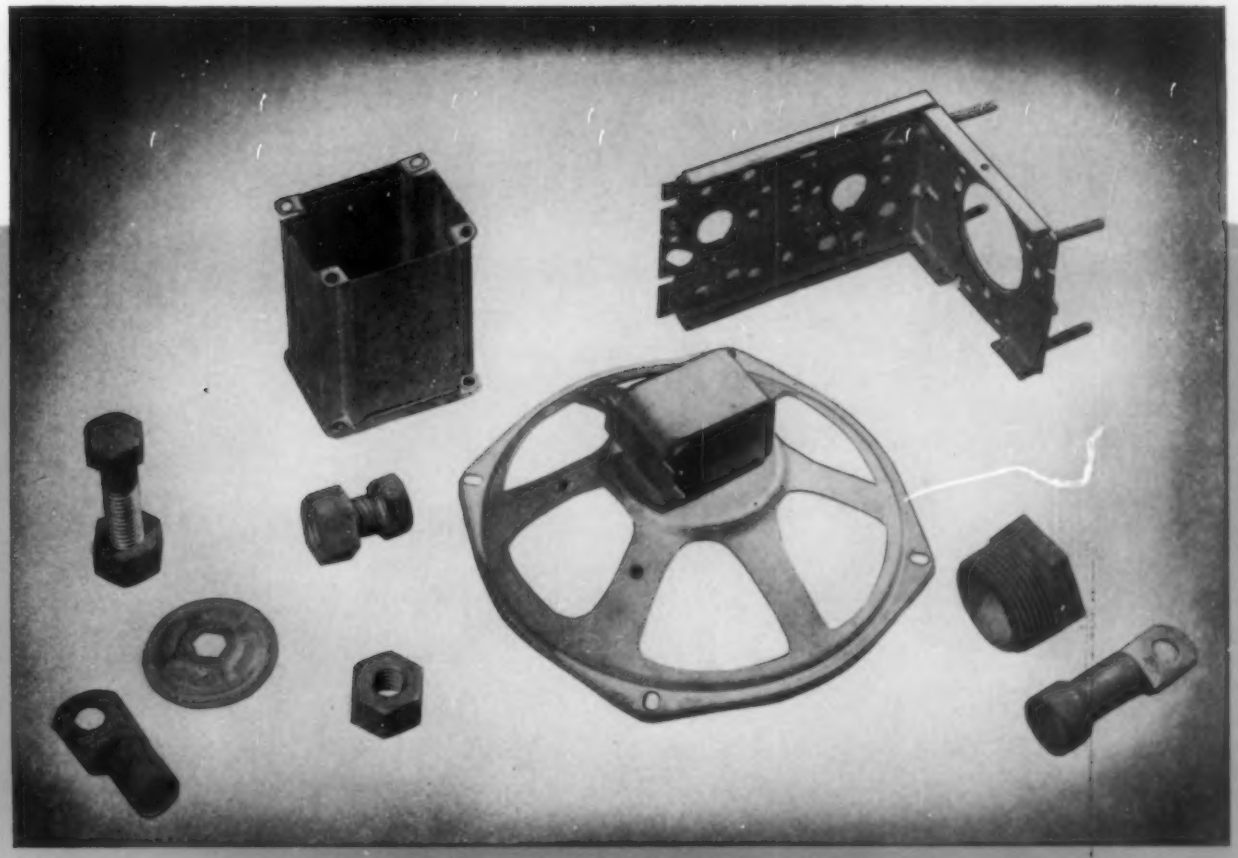


80-ton turret punch press to which control system has been adapted. Director unit houses card reader, command selsyns for each motion and operating controls. A control panel behind press (not visible) contains electronic and magnetic circuits which compare selsyn signals, and houses the drive motor controls. Motor visible below handwheels is one of two added for automatic table drive; but two hand wheels can still be used to manually position the table. Control box, part of original press setup, has been retained for manual operation of turret, punch and brake. Electronic eye stops machine should the light beam be interrupted during operation. The automatic control system approximately triples the speed of the manually operated press. Holdover manual functions—loading, clamp changing, unloading—limit this speed increase on short runs.

Automatically Positioned Turret Punch Press

To increase output rate, minimize scrap and reduce inspection time, a punched-card control system developed by the Specialty Control Dept., General Electric Co., Waynesboro, Va., has been applied to the Wiedemann turret punch press. Basic problem was three dimensional control—positioning the two table coordinates and governing the rotation of the turret. The control system makes possible automatic positioning, and positions via the most direct route point-to-point. Punch stroke is actuated simultaneous with card feed.

Specifications that had to be met were: (1) No modifications in basic machine; (2) a continuous operation cycle; (3) table cross-slide and in-feed speeds of 450 and 300 in./min., respectively, and turret rotation of 6 rpm; (4) punch accuracy of 0.010 in.; and (5) retention of manual operation. Major problems met were determining the best means for data storage and interpretation, developing a method for indicating position, and designing control circuitry for checking and amplifying signals and necessary power drives.



Courtesy Metal & Thermit Corp.

ALLOY PLATING IS USED on a variety of parts to enhance corrosion resistance and prolong the useful life of the part. Here is a representative collection of items which have been plated with a tin-zinc alloy.

and lead-tin alloys have recently been applied in the deposited form to provide a bearing metal. These alloys contain 93 per cent lead and 7 per cent tin. An alloy containing 40 per cent lead and 60 per cent tin has found application in the electronics field as a solderable coating.

A typical fluoborate solution used for plating lead-tin alloys is made up of fluoborate acid, boric acid, fluoborates of lead and tin and a very small amount of addition agents such as glue. The system operates at room temperature and current densities of from 20 to 50 amp per sq ft.

Lead-silver alloys: The addition of lead up to 4 per cent increases the hardness of silver and may widen the range of its industrial applications. Since this is a hard alloy, thin deposits may be used thus keeping the cost down to the level where it could be considered as a coating material.

It should be pointed out that deposited metals may be harder than the same metals in cast or wrought form. This is an added advantage in many cases. Electrodeposited lead-silver alloys for bearing uses have been softened by a suitable heat treatment. Solutions are made up of potassium cyanide, silver cyanide, potassium tartrate, potassium hydroxide and basic lead acetate. The solution operates at a temperature of 75 to 90 F with current densities up to 15 amp per sq ft.

Nickel-cobalt alloys: Cobalt may be codeposited with nickel to produce bright nickel deposits. Cobalt content of the deposit is in the range of 1 to 20 per cent.

Aluminum alloys: Work on the utilization of these alloys in electrodeposition is going forward. While tests indicate that there are some commercial possibilities for the use of these alloys, development work still needs to be done on control systems for the solutions.

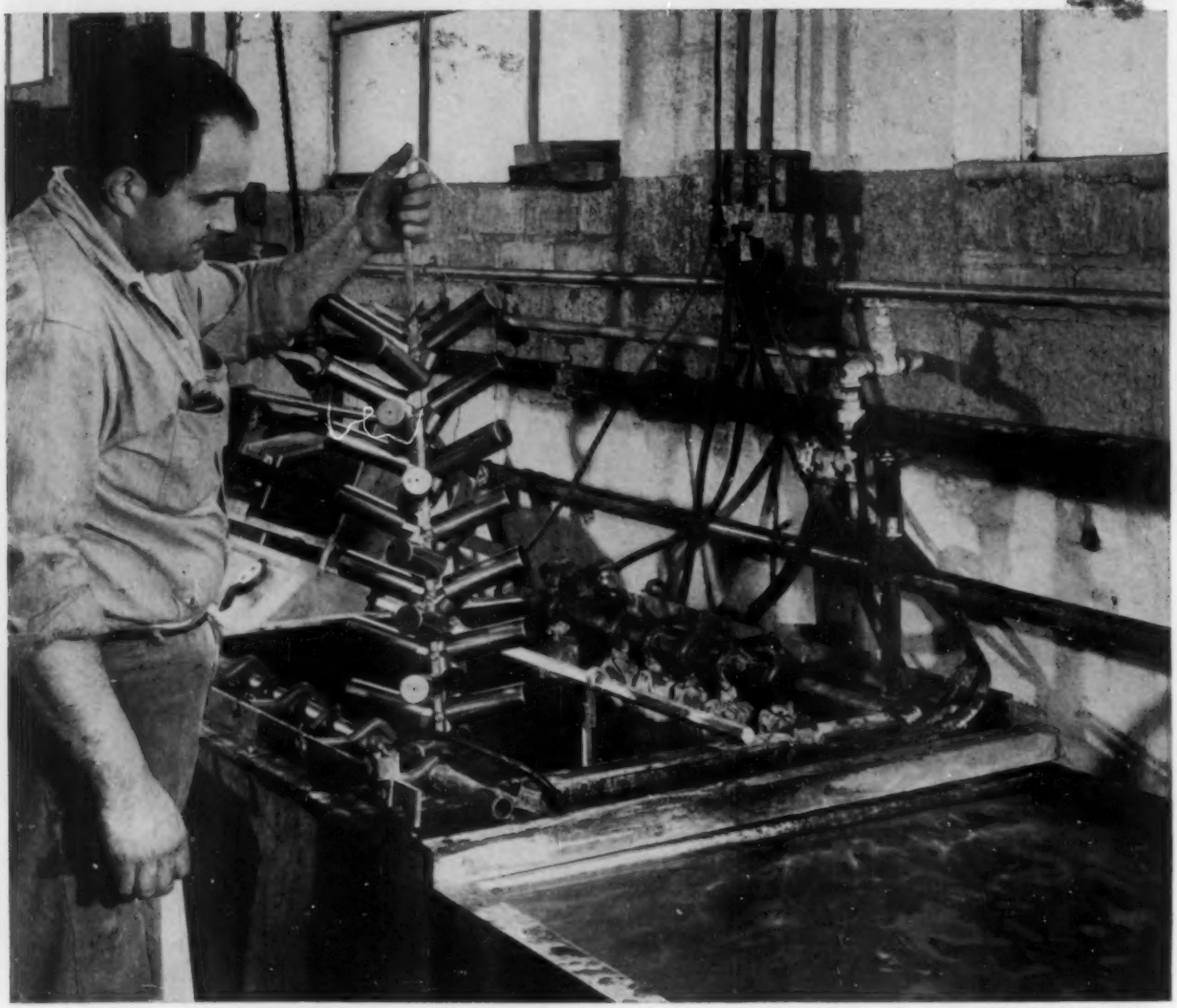
Tin Nickel Alloy: These metals are capable of simultaneous deposition in the form of an intermetallic compound of 65 per cent tin, 35 per cent nickel from a solution containing nickel chloride, stannous chloride and ammonia bifluoride. The solution operates at 150 F and 25 amp per sq ft to yield a hard, tarnish and corrosion resistant coating which is both pleasing in appearance and yet readily solderable. The solution shows unusually high covering and throwing power.

White Brass: This is a high zinc alloy containing about 20 per cent copper and is plated from a solution containing zinc cyanide, copper cyanide, sodium cyanide and sodium hydroxide. The bright alloy has been used as a substitute for nickel. It has good corrosion resistance but tends to form the white corrosion products typical of zinc deposits.

Tin-zinc alloys: This alloy has a nominal composition of 78 per cent tin and 22 per cent zinc. The solution contains potassium stannate, zinc cyanide, potassium cyanide and free potassium hydroxide and operates at 150 F plus or minus 5 F with a current density of 15 to 50 amp per sq ft.

The principal advantages of tin-zinc alloy are its excellent solderability and its retention of this property after aging. Soldering may be done in $\frac{1}{3}$ to $\frac{1}{4}$ of the time required for conventional finishes. The system is easy to control and has excellent throwing power. The widest use of parts plated with tin-zinc alloy is in the electronics industry.

Tungsten alloys: Because of their good chemical and physical properties at elevated temperatures tungsten alloys



Courtesy Century Plating Company

NON-MAGNETIC ALLOY PLATING of 0.0003 to 0.0005 in. thickness is deposited by 20 minutes immersion in a still tank. The throwing power of the solution adequately plates inside bottoms along with other surfaces of these cylindrical timing device cases. Plating operation shown here is on a tin-nickel alloy producing a hard tarnish-resistant coating with good solderability.

of iron, cobalt, and nickel have been investigated. Difficulties in the fabrication of these alloys has encouraged research on their deposition on more easily fabricated basis metals.

Electroplating Copper-Tin Alloy

The most promising corrosion-resistant undercoating for nickel-chrome plating is the copper-tin (bronze) alloy. When it replaces the copper in decorative copper-nickel-chrome plating, the copper-tin alloy increases corrosion resistance and offers other properties such as excellent coverage in recessed areas, high rates of deposition and hardness.

The copper-tin alloy can be used for finishing parts without the use of nickel, and offers more protection than the same thicknesses of copper under chromium. The alloy is also used as a decorative finish closely resembling 24 K. gold. It may be protected from tarnishing by lacquering.

The recommended alloy composition is approximately 88 per cent copper, 12 per cent tin. This may be varied considerably without affecting the properties of the deposit except the color and without causing any difficulties in the application of further coatings.

The process uses copper anodes and tin is supplied to the bath by potassium stannate.

Properties of the Deposit

By the use of a brightening agent the alloy can be plated in a fully bright condition. Otherwise, a dull but easily buffed deposit is obtained. The ability to be plated in either the dull or bright condition provides a finish with a great number of possible applications. When copper-tin is substituted for copper in the copper plus chromium or copper plus nickel plus chromium systems the corrosion resistance is markedly superior.

The alloy is highly ductile when plated in the dull condition and only slightly less so when plated bright, thus permitting some bending of the part after plating. Copper-tin is harder than copper and approaches the hardness of nickel so that, mechanically, it provides an

Courtesy Century Plating Company

SMALL PARTS, in quantity, are alloy-plated in a Lucite barrel to reduce costs. This method results in the same solderability, tarnish resistance, and good appearance obtainable in the still bath. Deposition is held constant at 65 percent tin and 35 per cent nickel.

excellent undercoat for nickel or chromium. Its hardness has been reported to be approximately 325 Vickers. The alloy buffs more readily than copper, with less tendency to "drag" or cut through. The copper-tin alloy in either the buffed or bright plated condition has a very attractive appearance; it is richer and more golden in color than brass.

The throwing power of the bath is superior to the various copper plating solutions. It has been possible to plate parts in the alloy plating solution that could not be satisfactorily covered in a copper strike without special racking fixtures. Plating speeds in excess of 0.0001 in. per minute have been attained at current densities over 100 amp per sq ft. Deposits are smooth without excessive build-up.

If correct pre-treatment is applied, the alloy can be plated directly on good quality zinc base die castings without prior flash plating. If any difficulty is encountered in obtaining good adhesion, the parts may be flashed with copper prior to bronze plating. For the plating of aluminum, bronze may be used in place of copper over immersion zinc for better coverage and corrosion resistance.

Uses of Copper-Tin

This combination of properties suggests a number of uses for this alloy finish. It can be substituted for copper in the copper-chromium or copper-nickel-chromium cycles to provide a more corrosion resistant finish. The alloy can also be used in place of copper where covering power is important to obtain better coverage in recesses and hence better appearance and corrosion resistance.

Copper-tin can be plated directly on die castings in many cases to achieve cost savings. Since a strike is often not necessary, one plating operation and several water rinses may be removed from the cycle. As a decorative coating, copper-tin can be used in place of brass to provide an attractive finish and to eliminate many of the usual problems of control in the plating operation.

The Process

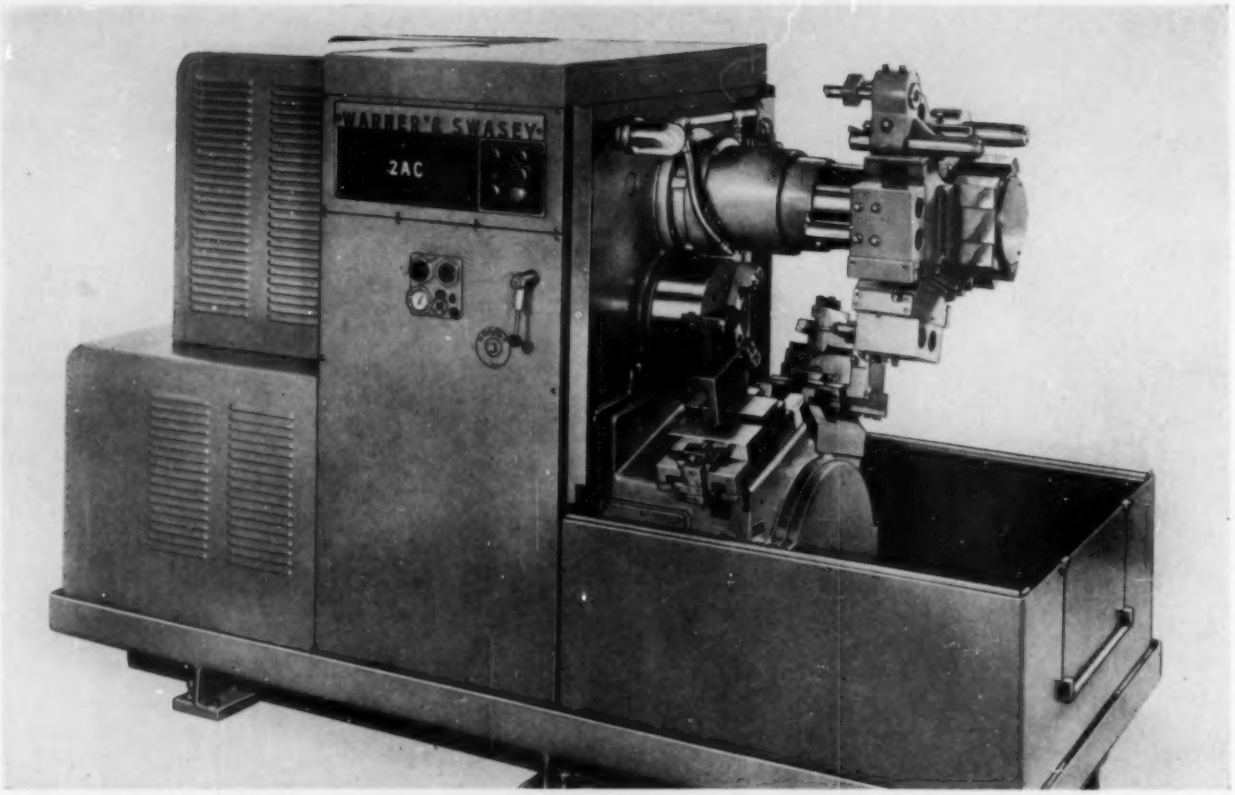
The solution consists of potassium cyanide, copper cyanide, potassium hydroxide, potassium stannate, and Rochelle salt. It operates at a temperature of 145 to 160 F with current densities up to 100 amp per sq ft.

Deposition Control

Changes in the temperature as well as the cyanide and hydroxide contents of the solution will cause a variation in color. High temperature and high free potassium cyanide with low free potassium hydroxide concentrations favor the deposition of a higher tin alloy yielding a golden color. Conversely, lower temperatures with lower free potassium cyanide and higher free potassium hydroxide favor the deposition of red bronze with a higher copper content.

Brightener additions can be readily controlled by the use of a Hull cell. Excessive amounts of brightener in the solution can cause brittleness in the deposit. Cases of laminar deposits have been observed when plating bright bronze if the parts are removed from a bath containing a high concentration of brightener exposed to air, and an attempt is made to continue plating on them without other treatment. This may be eliminated if the parts are rinsed, acid dipped and rinsed again prior to replacing in the plating tank or if they are allowed to remain in contact with the solution for a few seconds before the current is reapplied. It is generally advisable to lower the brightener concentration when this condition is observed.

DESIGN FEATURES



Turret Lathe Designed for Operator Convenience

Two major design objectives guided the development of the new Warner & Swasey 2AC single-spindle chucking lathe: Eliminate every time-consuming set-up adjustment, and design for operator convenience.

Some gains in both aims had been incorporated in earlier designs of other tools, particularly in simplification of set-up functions; but in this new 2AC turret lathe every set-up adjustment is positioned at a good work height under the hood at the left end of the machine. Operation during the work cycle is completely automatic, initiated by pushing one button after the work is chucked.

LAYOUT of controls (right) was dictated by function. Controls for automatic operation—cycle start, motor start, spindle jog, coolant, and emergency stop are positioned flush on the head close to the spindle near the operator. The stop button extends further than the others so it can be operated blind in an emergency. All other controls (used only for set-up and manual operation) are recessed and covered by a drop door which is closed during automatic operation.

Control panel for air chuck is a purchased unit, and arrangement of controls, other than position of the panel, was not under control of designer. Unit is positioned as high as possible, but since only infrequent observation or adjustment is required the location used is acceptable. To encourage daily check of oil level and draining of condensate, and set-up adjustment of pressure, the front panel position was preferable to a location under hood at left end of machine.

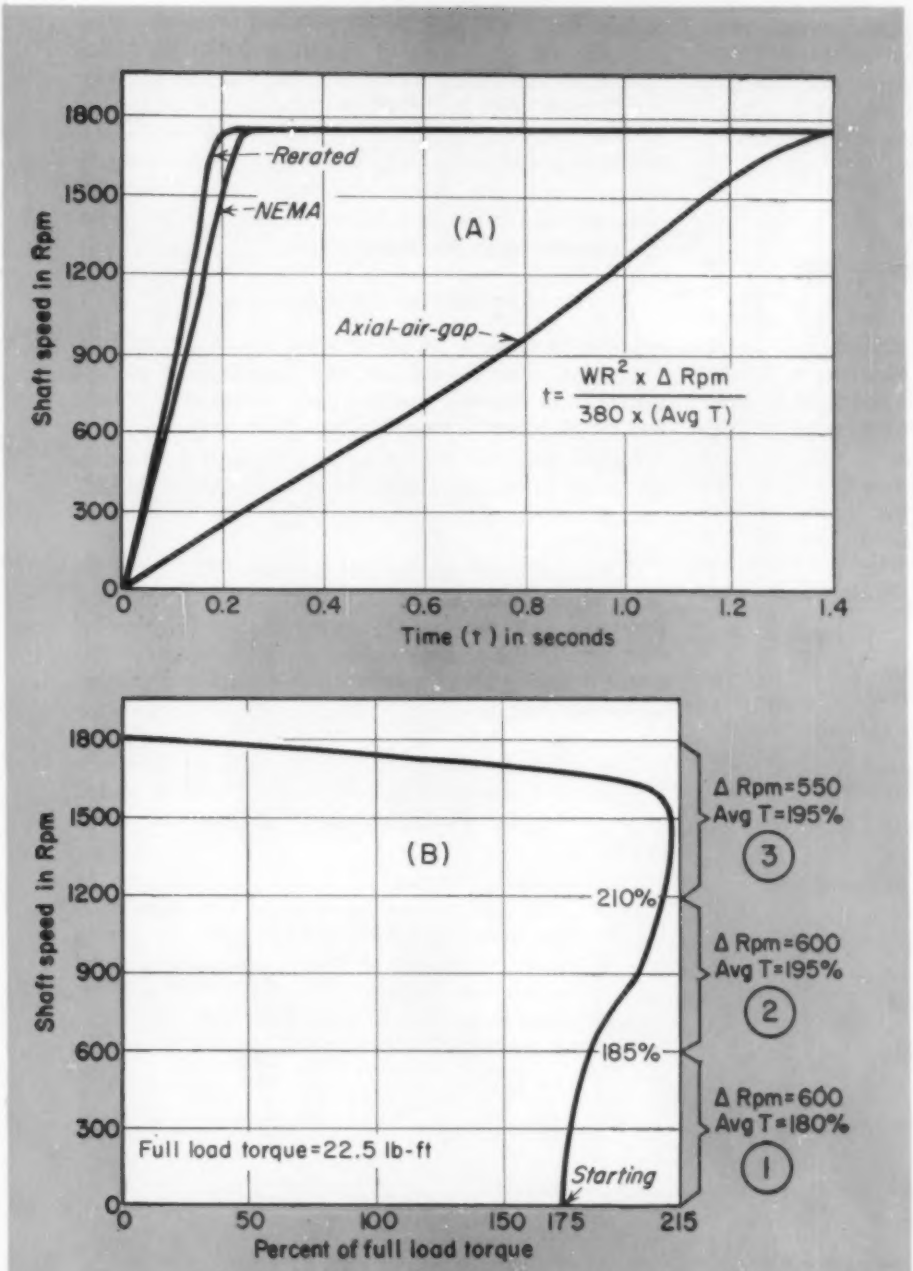


Fig. 5—(A) Comparison of accelerating times of axial-air-gap, old NEMA and rerated NEMA 1800, 7-½ hp motors. (B) Speed-torque curve of NEMA Design B motor showing increments of shaft speed chosen from calculation of acceleration times for both NEMA and axial-air-gap motors. Numbers *1*, *2* and *3* indicate sequence of calculation.

Available Types

Axially-air-gap motors are available in ½ to 15 hp ratings with torque and temperature characteristics corresponding to NEMA Design B, and Design C, and Design D motors. Physical dimensions, which differ from NEMA standards are listed in Table I.

The standard axial-air-gap motor, shown in Fig. 1, meets the requirements of drip-proof standards. The totally enclosed, non-ventilated motor is provided by using a blank cover in place of the perforated one shown. Totally-enclosed fan-cooled motor, shown in Fig. 4(A), is available for operation in adverse ambient conditions. The axial-air-gap motor is normally supplied as a flange-mounted unit, but a pivot base for foot mounting, shown in (B), can be provided for belt drives. Also, the basic components of the motor can be incorporated as an integral part of the design; stators and rotors can be supplied without the frame, shaft, or bearings.

Axial-Air-Gap vs Conventional

The axial-air-gap motor, when compared to the equivalent conventional motor, is smaller and lighter, but has considerably higher rotor inertia and slower acceleration. These factors are listed in the Table II which compares 1800-rpm, flange-mounted, axial-air-gap motors with the equivalent foot-mounted old NEMA and rerated NEMA motors.

The reduction in size and weight is obtained in the axial-air-gap unit by (1) more compact assembly of core materials and windings, (2) a reduction in the size of the supporting frame, and (3) a more efficient cooling system.

Rotor inertias from five to 15 times that of equivalent conventional types results from the rotor diameter being equal to the motor diameter. This increased inertia lengthens the acceleration period. Accelerating time of the axial-air-gap, old NEMA, and rerated NEMA 7½ hp 1800-rpm motors are compared in Fig. 5. These curves were calculated from the Design B speed-torque characteristics shown in (B) using the following formula:

$$t = \frac{WR^2 \times \Delta Rpm}{308 \times T}$$

Where t = time in sec

WR^2 = rotor inertia in lb-ft²

ΔRpm = change in rpm over selected increment in shaft speed.

T = torque in lb ft

Since the accelerating torque is not substantially constant over the accelerating period, the accelerating time is calculated in specific increments of increase in speed. The torque used is the average available during the chosen increment and is indicated by the brackets *1*, *2*, and *3* at the right of the speed-torque curve.

Flywheel Effect

The flywheel effect of the axial-air-gap rotors must be evaluated in applying these motors. Table II indicates that where the inertia of a conventional motor might be insignificant, that of the comparable axial-air-gap unit is considerable. However, in applications with intermittent loads on the drive or where it is desired to maintain shaft speed despite momentary peak loading, the high inertia is an advantage.

For example, if a 7½ hp, 1800-rpm motor is to be used to drive the flywheel of a punch press through a drive ratio of 5 to 1 the WR^2 of the axial-air-gap motor is 10.5 lb-ft², while that of the same rerate motor is 1.5 lb-ft², as shown in Fig. 6. The effective inertia of the motor at the flywheel shaft or driven speed is:

where:

$$(WR^2)_2 = (WR^2)_1 \times \left(\frac{\text{Rpm}_1}{\text{Rpm}_2}\right)^2$$

$(WR^2)_2$ = effective inertia of motor at flywheel shaft.
$(WR^2)_1$ = inertia of motor.
Rpm_1 = motor-shaft or driving speed.
Rpm_2 = flywheel-shaft or driven speed.

For NEMA rerate motor:

$$(WR^2)_2 = 1.5 \times \left(\frac{1750}{350}\right)^2 = 37.5 \text{ lb-ft}^2$$

For axial-air-gap motor:

$$(WR^2) = 10.5 \times \left(\frac{1750}{350}\right)^2 = 262.5 \text{ lb-ft}^2$$

Machines requiring the flywheel effect for delivery of peak horsepower at periodic intervals can utilize the axial-air-gap motor in two ways: (1) the additional inertia of this type motor can replace a portion of the machine flywheel, or (2) with the same flywheel a smaller hp rating may be used. For full utilization of motor WR^2 the motor should be geared to the load. V-belt drives, unless specially designed, will not deliver maximum energy from the motor flywheel in the short interval of time that the punch or shear requires its maximum torque.

Application Considerations

Saving in space is the prime advantage of the axial-air-gap motor. For example, in one application a pair of ½-hp gear motors were mounted back to back with a brake and clutch between, requiring only 26 in. overall.

Lighter weight of the axial-air-gap motor is a secondary advantage; in machines requiring movable elements which mount a motor, this reduction in weight can be of special significance.

Open drip-proof motors require minimum space for most applications. In these motors the cooling air is thrown against the curved contour of the cover rather than against the stator windings as in the conventional motor, reducing abrasive wear on the winding insulation when rock dust, or other sharp particles are carried in the air.

Greatest space saving is obtained when the motor is supplied as a rotor and stator assembled and integrated as a part of the driven equipment designed, as shown in Fig. 7.

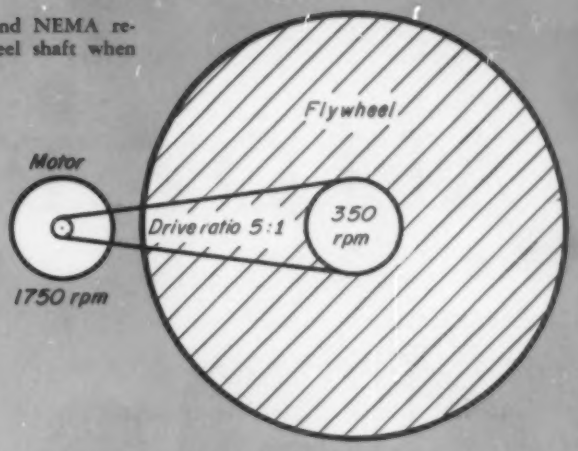
Totally-enclosed nonventilated units, available up to 3 hp at 1800 rpm, require larger frame sizes than open motors. The nonventilated motor can be used for driving fans or blowers where the air stream provides additional cooling; in this case the same frame size as the corresponding open motor may be applied.

Enclosed fan-cooled motors are designed for use in

Table II—Comparison of 3-phase, 1800-rpm flange-mounted air-gap and foot-mounted old NEMA and rerated motors. Data is approximate. Length is measured from closed end of motor to outside of bearing closure at shaft end.

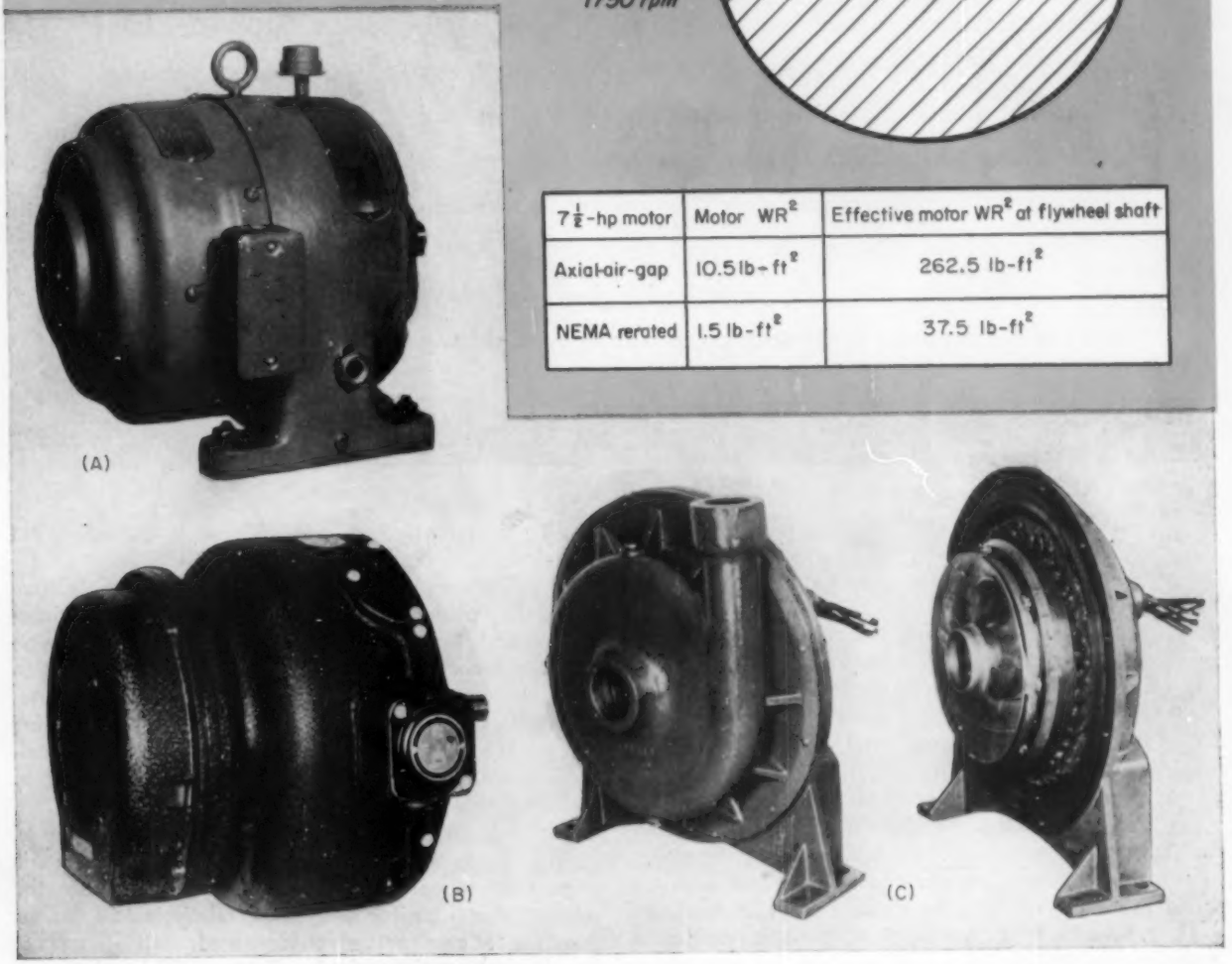
Hp Rating	Principal Dimensions, in.						Net Weight, lb			Rotor Inertia, lb-ft²		
	Length			Diameter								
	Axial	NEMA	Rerated	Axial	NEMA	Rerated	Axial	NEMA	Rerated	Axial	NEMA	Rerated
1	6 3/16	11 5/8	9 7/8	10 3/8	9 1/4	9	41	75	48	1.0	0.25	0.20
1.5	6 13/16	12 5/8	10 7/8	12 1/8	9 1/4	9	54	85	57	1.9	0.30	0.23
2	6 13/16	13 5/8	10 7/8	12 1/8	10 3/4	9	60	95	57	2.3	0.35	0.25
3	8 1/4	14 3/8	12 3/8	13 1/8	10 3/4	10 3/8	94	110	97	5.5	0.50	0.37
5	8 1/4	16 5/8	13 7/8	14 1/8	12 1/4	10 3/8	111	150	105	7	1.1	0.56
7.5	9 9/16	18 7/8	16 5/8	16 3/8	13 5/8	12 5/8	148	185	157	10.5	1.8	1.5
10	9 9/16	20 13/16	18 3/8	16 3/8	15 1/2	12 5/8	172	245	190	13.0	2.6	1.7
15	11	22 5/16	18 7/8	17 7/8	15 1/2	14	294	270	255	19.2	3.5	2.5

Fig. 6—Comparison of axial-air-gap and NEMA re-rated motor inertias effective at flywheel shaft when coupled through gear drive.



7½-hp motor	Motor WR^2	Effective motor WR^2 at flywheel shaft
Axial-air-gap	10.5 lb-ft^2	262.5 lb-ft^2
NEMA rerated	1.5 lb-ft^2	37.5 lb-ft^2

Fig. 7—Examples of integrating axial-air-gap motor into design. (A) Gearmotor, (B) motor with Warner brake, and (C) centrifugal pump by Leakproof Pump Co.



atmospheres containing metallic particles, oil mist, or other mechanical suspensions of materials which would attack the windings. Frame sizes are the same as open motors in some ratings, and for the larger ratings are a frame size larger.

Tolerances for shaft runout are less than for conventional motors because of the design of the interior supporting frame. This is an advantage in the direct-shaft mounting of fans, impellers, or other devices which require close clearances for proper operation.

Replacement of a successfully applied conventional motor by a smaller axial-air-gap motor of the same rating will not fully utilize the space-saving advantages of this motor; this can only be accomplished when the space saved can be put to effective use through redesign of the drive and motor mounting.

FOR FURTHER READING: In this continuing program of articles on the selection and application of motors for machine tool drives a detailed analysis of NEMA Design B, C, and D torque-speed ratings was made in "The Importance of Duty Cycle in Selecting Polyphase Induction Motors," November 1954 page 174. Detailed calculations of accelerating time were also included. An earlier article "How Big a Motor" in September 1952 page 142, reviews four methods for determining proper motor rating: calculating from motor data, using load-torque tests, making metered running tests, and taking temperature rise on a heat run.

ALLOY PLATING

Recent developments in the plating of alloys — rather than pure metals — offer some new and interesting combinations of properties and appearance for product finishing.

The first part of this article evaluates available alloys and plating methods, properties, advantages and limitations, and basic plating procedure for brass, some tin, nickel and silver alloys, and other compositions, some still in development.

The second part discusses the copper-tin (bronze) alloy, a corrosion-resistant undercoating with better throwing power and higher rates of deposition than copper. Properties of the deposits, applications, and plating procedure.

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ELECTRODEPOSITED ALLOYS offer advantages in abrasion resistance, appearance, corrosion resistance and economy. For example, reduction in metal costs can be accomplished by using copper-tin to replace nickel. The use of brass and gold alloys results in special and variable color effects while bright deposits can be obtained by the deposition of nickel-cobalt and nickel-tin. Deposited alloys have other special advantages such as solderability, rubber adhesion and tarnish resistance. The possibility exists of depositing rarer metals in alloy forms even though these metals do not make satisfactory platings by themselves. The most important advantage for the use of alloy plating is that it provides combinations of properties which are not obtainable through the use of a single metal.

There were, however, certain problems encountered in the process that were not found in the electrodeposition of single metals. Inability to control the composition of the deposits was a distinct disadvantage which retarded the general use of alloy plating. Some of the alloys which are electrodeposited in commercial volumes are brass, lead-tin, tin-nickel, cadmium-silver, tin-zinc, tungsten alloys and bronze.

New solution formulations and improved control techniques have overcome this difficulty in many cases so that now such alloys as brass, white brass, various golds, tin-zinc, lead-tin, tin-nickel, nickel cobalt and several bronzes are plated in commercial volumes. In addition to these, the two ternary alloys, copper-tin-zinc and lead-antimony-tin have found practical application.

Brass has been one of the most popular of the plating alloys. It provides a good decorative and protective finish for iron and steel and is an excellent base for the adhesion of some rubber compositions to steel and other metals. Brass plating solutions, made up of a number of constituents each with a definite influence on the alloy plating process, have been subjected to intense investigation with the result that deposition factors have been evaluated so that the process can now be more closely controlled.

The sodium consists of copper cyanide, zinc cyanide, sodium cyanide and usually sodium carbonate. Ammonia or proprietary materials are often added to regulate the color of the deposits. In general, relatively low current densities, 5 amp per sq ft, are used. Higher current densities reduce the cathode efficiency. This solution is operated at room temperature or higher, has good throwing power and results in a uniform color if close attention is given to solution composition and operating temperature. Arsenic is used to lighten the color.

Speculum Metal is a hard silvery-white alloy of copper and tin used for polished reflectors. Its hardness and resistance to corrosion make it suitable for many applications. One solution is made up of tin, copper, free-sodium cyanide and caustic soda. It is necessary to use separate copper and tin anodes. Recently a new solution has been developed using alloy anodes and yielding bright deposits.

Lead-tin alloys: The deposition of lead-tin alloys is becoming a common operation. Solutions containing the fluoborates of the metals are being worked successfully

Trends in the design of machine tools call for more hp in smaller space; specifically, less overhang for flange-mounted motors. Here are four examples of the use of axial-air-gap motors: (A) Turret milling machine by Bridgeport Machine Co. (B) Duplex corner cutter for cardboard cartons by Hobbs Mfg. Co. (C) Milling machine by Gisholt Machine Co. (D) Contour milling machine by Gorton Machine Co.

Axial-Air-Gap Motors for Machine Tool Drives

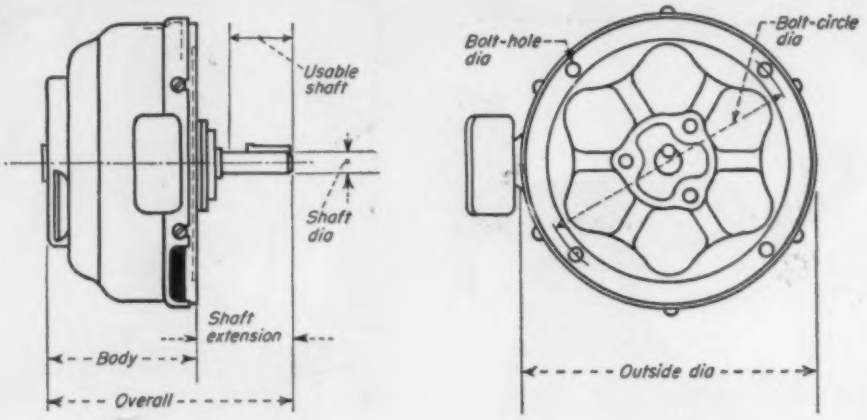
JOHN MERRIELL, CHIEF APPLICATION ENGINEER, FAIRBANKS MORSE & CO.

THE AXIAL-AIR-GAP, or "pancake" motor as it is sometimes called, is a three-phase induction motor with a flat cylindrical rotor and stator; electrically it is the same as a conventional motor, but mechanically the rotor turns in a plane parallel to the stator instead of rotating inside it.

In both conventional and axial-air-gap polyphase motors a rotating flux is produced by currents in the stator windings; this flux crosses the air gap and into the rotor, causing currents in the rotor conductors and producing the rotational torque.

Mechanical relationship of principal components of the axial-air-gap motor is shown in Fig. 1. The rotor laminations are welded to the cast rotor spider which supports the rotor assembly; spider ribs act as a fan. In operation the fan throws

TABLE I—Ratings and Principal Dimensions



Frame No.	Horsepower Ratings											Synchronous Speed in Rpm				Principal Dimensions (in inches)							
	1/3	1/2	3/4	1	1 1/2	2	3	5	7 1/2	10	15	900	1200	1800	3600	Body	Overall	Shaft Extension	Usable shaft Length	Shaft Dia	Bolt-circle Dia	Outside Dia	Bolt-hole Dia
4060	x												x			5	8	3	2	3/4	7-3/4	8-1/2	21/64
		x												x									
L4060		x	x												x	5-11/16	8-11/16						
4267			x											x		5-1/4	8-1/4				8-3/4	9-1/2	
4570	x											x				5-11/16	8-7/16	2-3/4			9-1/4	10-1/4	13/32
		x											x										
				x										x									
L4570				x	x										x	6-5/8	9-3/8						
5285		x	x									x				5-15/16	9-13/16	3-7/8	2-3/4	1	11	12	
			x	x									x										
					x	x								x									
L5285						x	x								x	7-1/8	11						
6095				x								x				7-1/4	11-5/8	4-3/8	3-1/8	1-1/8	12	13	
					x								x										
							x							x									
60105					x							x									13	14	
						x							x										
								x						x									
L6095								x							x	9-1/8	13-1/2				12	13	
L60105									x	x					x						13	14	
65117						x	x					x				8-9/16	14-7/16	5-7/8	4-5/8	1-5/8	15	16-1/4	17/32
							x	x					x										
									x	x				x									
70130								x				x				10	15-7/8				16	18	3/4
									x	x			x										
											x			x									

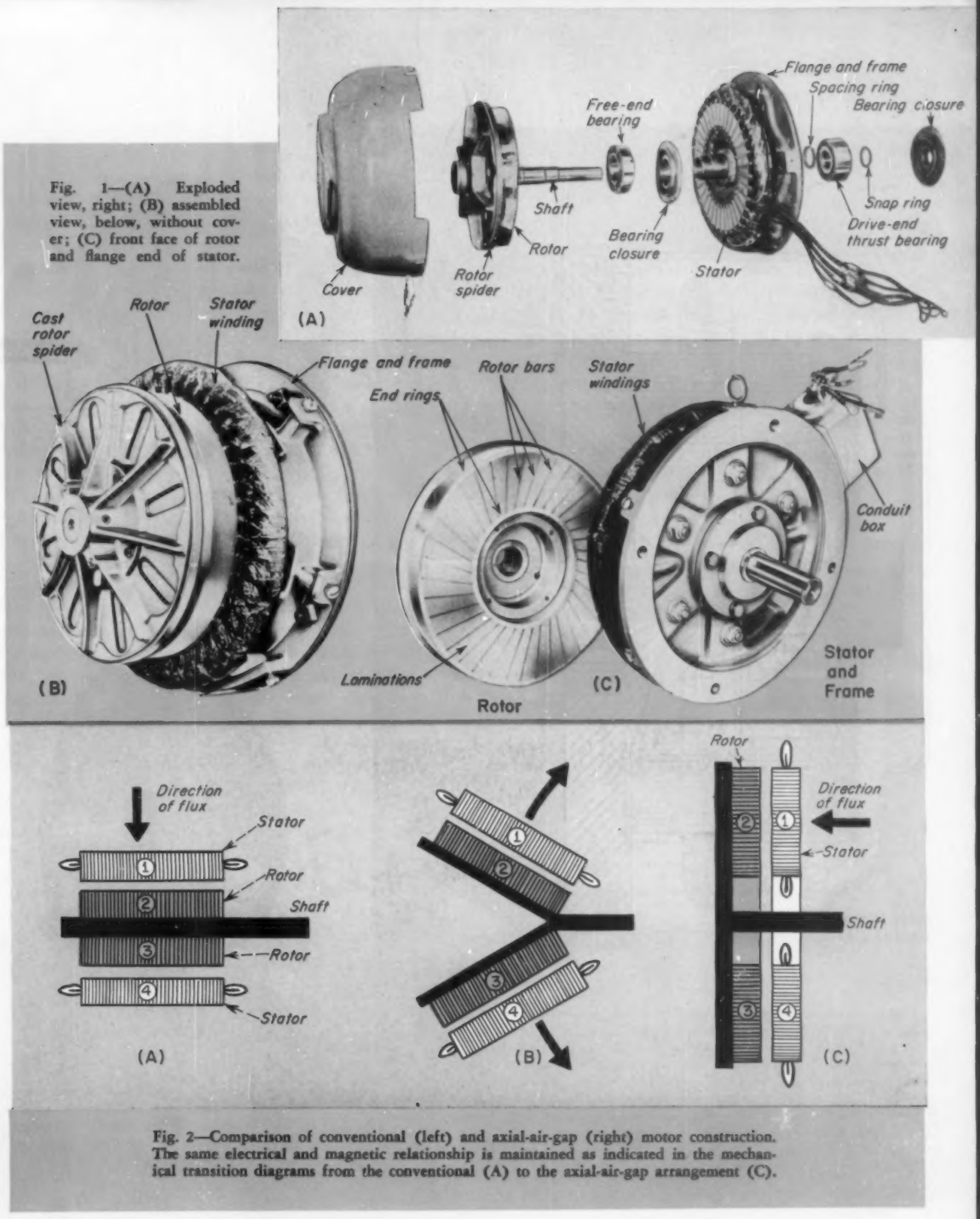


Fig. 1—(A) Exploded view, right; (B) assembled view, below, without cover; (C) front face of rotor and flange end of stator.

Fig. 2—Comparison of conventional (left) and axial-air-gap (right) motor construction. The same electrical and magnetic relationship is maintained as indicated in the mechanical transition diagrams from the conventional (A) to the axial-air-gap arrangement (C).

a cooling air stream radially outward across the face of the rotor where it is directed downward by the cover. This construction provides more efficient cooling than in conventional types. Rotor cover also acts as a guard for stator coils.

In a conventional motor flux flows from the stator to the rotor at right angles to the plane of the air gap and the shaft, as shown by the heavy arrow on te basic sectioned view of the conventional motor at the left of Fig. 2. In the axial-air-gap, shown at the right, the flux also crosses from rotor to stator at right angles to the plane of the air gap but now in a direction parallel to the shaft.

The development of the axial-air-gap motor from the conventional is indicated in Fig. 2 and is produced by spreading the conventional rotor and stator (A) through the intermediate step in (B) until flattened to an angle of 90 deg to the shaft as shown in (C). The same lamination faces, indicated by *1*, *2*, *3*, and *4*, face each

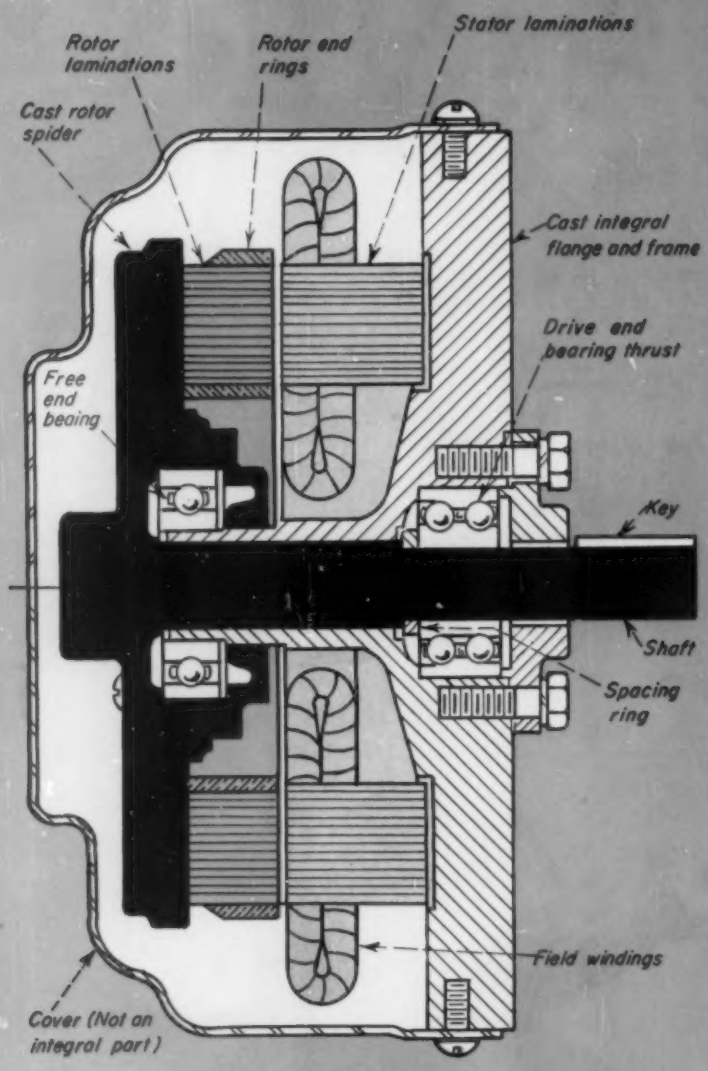


Fig. 3—Mechanical relationship of rotor and stator of axial-air-gap motor. Shaft end play in this type motor is within tolerances not obtained with conventional types. In the standard axial-air-gap motors shown here, rotor and stator laminations are welded to their supporting members. Separate stators with welded studs and rotors, with or without spiders, are supplied for designers who wish to incorporate the motor using their own bearings, shaft and bearing structure. Such arrangement saves greatest space.

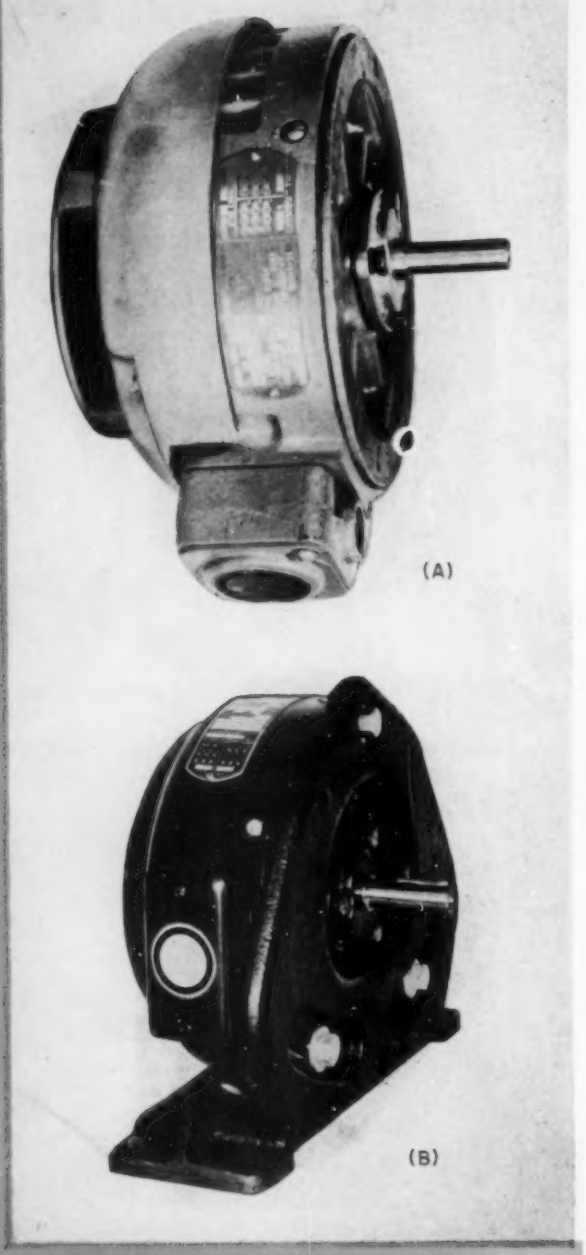


Fig. 4—(A) Totally enclosed, fan-cooled axial-air-gap motor. (B) Enclosed drip-proof motor and pivot base for foot mounting where required.

other across the air gap; the flux moves around the shaft but now parallel to it.

The unique construction of the axial-air-gap stator and rotor is produced by using long strips of electrical steel punched and wound to form a thick laminated ring. Relative operating positions of the rotor and stator are shown in the cross-section view of the motor in Fig. 3.

The stator has conventional three-phase windings and the rotor has centrifugally cast bars and copper end rings on the inside and outside surfaces of the rotor laminations. The rotor and shaft are supported by front and rear ball bearings. The drive-end bearing is a double-row, high-thrust type which carries the external radial load as well as the thrust load produced by the magnetic pull between the rotor and stator. Because of this feature the motor may be mounted either vertically or horizontally without requiring special design provisions to compensate for the wide permissible variations in mounting position.

forced up the same amount. To drop the load, flow through the four-way valve is reversed, and oil from the lower sides of the cylinders is metered through the hydraulic gear motors and back to the oil reservoir.

If the lift shoes and cylinders are unequally loaded, the motor associated with the lightly loaded cylinder will drive the other motors as a pump, maintaining equal flow into all four cylinders. In effect, the power supplied is divided equally by the four gear motors even though the cylinder load may be unbalanced.

When released, the valve spool returns to its center position and the blocked ports hold the load in place. Leakage in the valve is so small an amount that fairly long trips can be made without noticeable lowering of the lift shoes. Leakage through the motors is only possible when there is a pressure drop across the motor, that is, when an unequal load is carried by the four cylinders; even then, the leakage produces only minor variations in piston displacement.

After long periods of use, cumulative variations may require resynchronization of the cylinders. This is accomplished by running the lift shoes to the ends of the strokes and holding the valve open; with full oil pressure across the motor whose cylinder is still short of its end stop, leakage across this motor will even out the lift shoes after a few minutes.

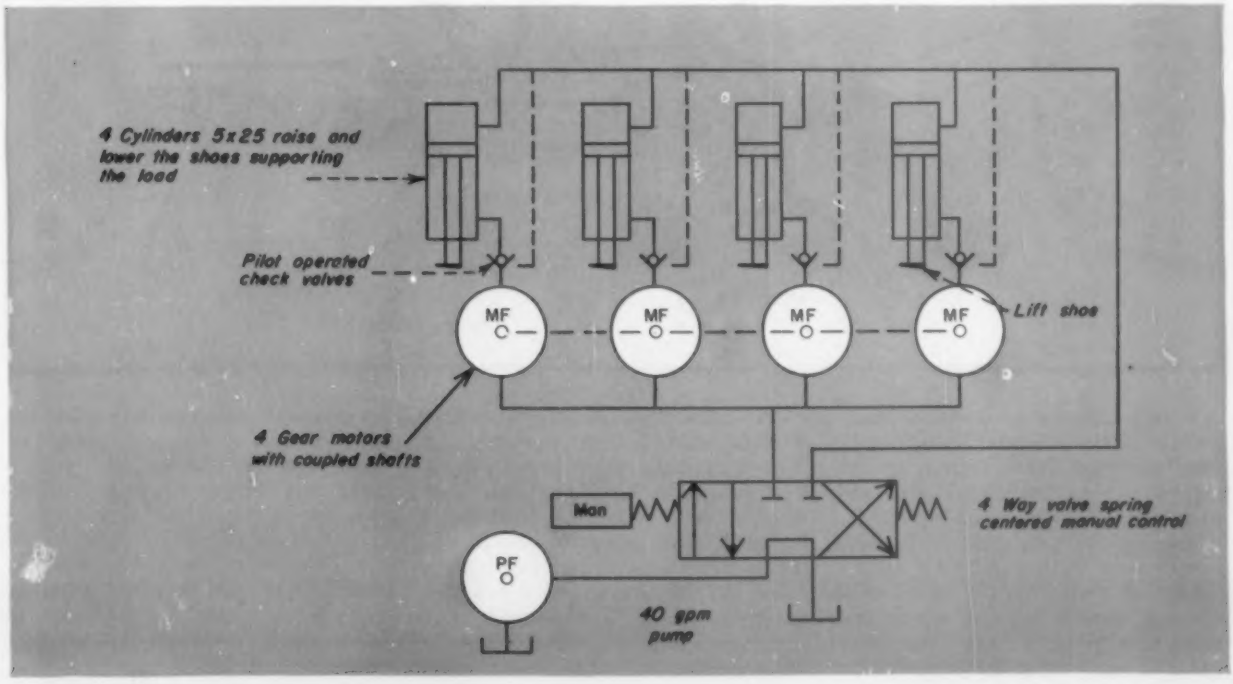
Pilot operated check valves between each cylinder and motor are controlled by the pressure in the line at the opposite side of the cylinder. Unless the opposite side is pressurized, discharge flow is not permitted and the piston will be held in place. This is a safety precaution to prevent the load from falling in the event that broken lines or connections discharge oil.

When the valve spool is moved only a small amount off center the pump is still sending oil through to the reservoir but the port to the cylinders may also be partially open. If unrestrained, oil from the cylinder would discharge to the oil reservoir permitting the load to drop. To prevent this, pilot operated check valves are installed in the line to the cylinders from the gear motors. These check valves are mounted in the line and prevent cylinder flow to the reservoir until the pressure is sufficient to support load carried by the cylinders.

This system, employing standard, inexpensive components, synchronizes the displacements of four cylinders without sacrificing power or safety.

Truck Performance Specifications

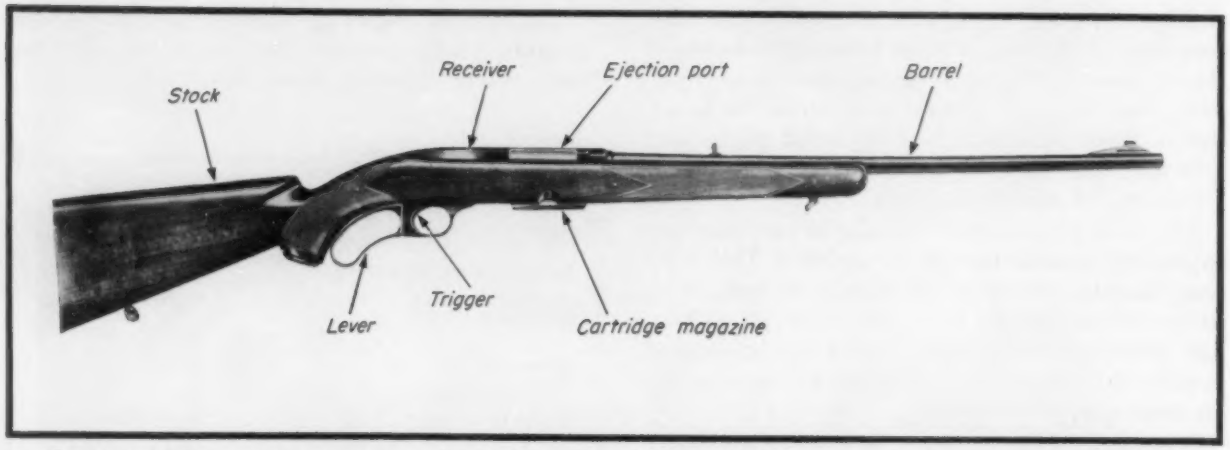
Load capacity, maximum		60,000 lb
Load dimensions	length	9 ft 2 in.
	width	6 ft 2 in.
	height	5 ft
Left, maximum		25 in.
Truck dimensions	length	18 ft 2 in.
	width	10 ft 6 in.
	height	12 ft 4 in.
Wheelbase		13 ft 6 in.
Engine		6 cyl, 180 hp
		450 ft lb torque



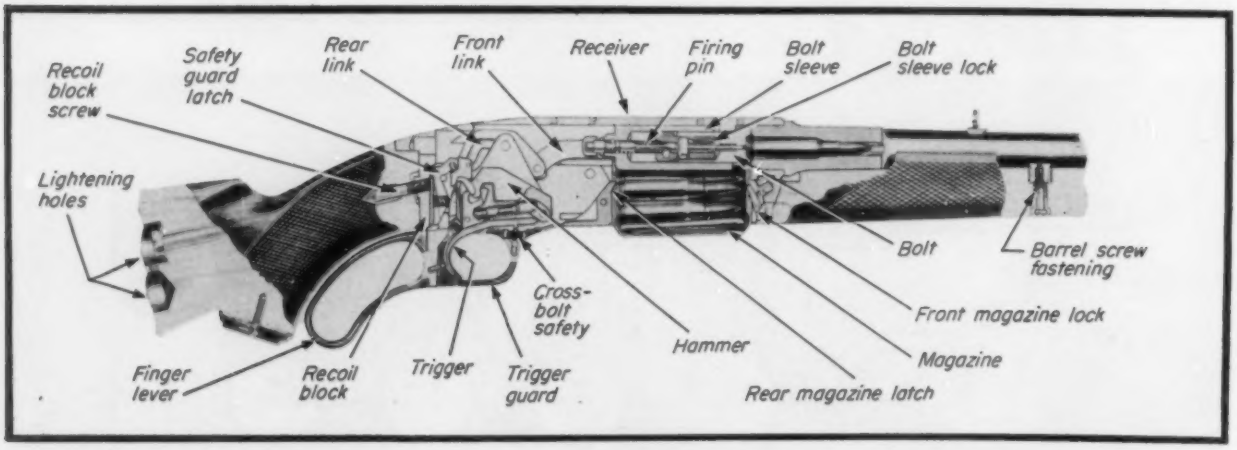
High-Power Lever-Action Rifle

To develop a lever action rifle capable of firing a cartridge giving a muzzle velocity of approximately 3000 ft/sec was the basic aim of the Winchester Arms and Ammunition Div, Olin Mathieson Chemical Corp., New Haven, Conn. in the design of the Model 88 sporting rifle.

Requirements were (1) one-piece stock; (2) center of gravity unaffected by number of cartridges in the magazine; (3) lever stroke of less than 100 deg; (4) completely closed ejector port with case injection at an acute angle; (5) trigger to rotate with lever with complete safety.



One-piece stock was desired to minimize barrel vibration and facilitate fast take-down. In the receivers of all previous lever action rifles, the section through the linkage which converts lever rotation to reciprocating bolt action was too thick for the stock to embrace the receiver. Practical maximum section for a one-piece stock was about 1⅛ in., obtained in the new design by using high-strength steels which made possible reduced thickness of section components.



Barrel is secured at front of stock by single screw; second screw through stock butt holds recoil block, in turn supporting rear of receiver. The barrel and receiver assembly are located to place the center of gravity at the center of the magazine; balance is thus unaffected by the number of cartridges in the magazine. To withstand pressure required to develop a bullet velocity of 3000 ft/sec, the breech lock is at the front of the bolt; less pressure is transmitted along length of bolt, subjecting the receiver to less stretch.

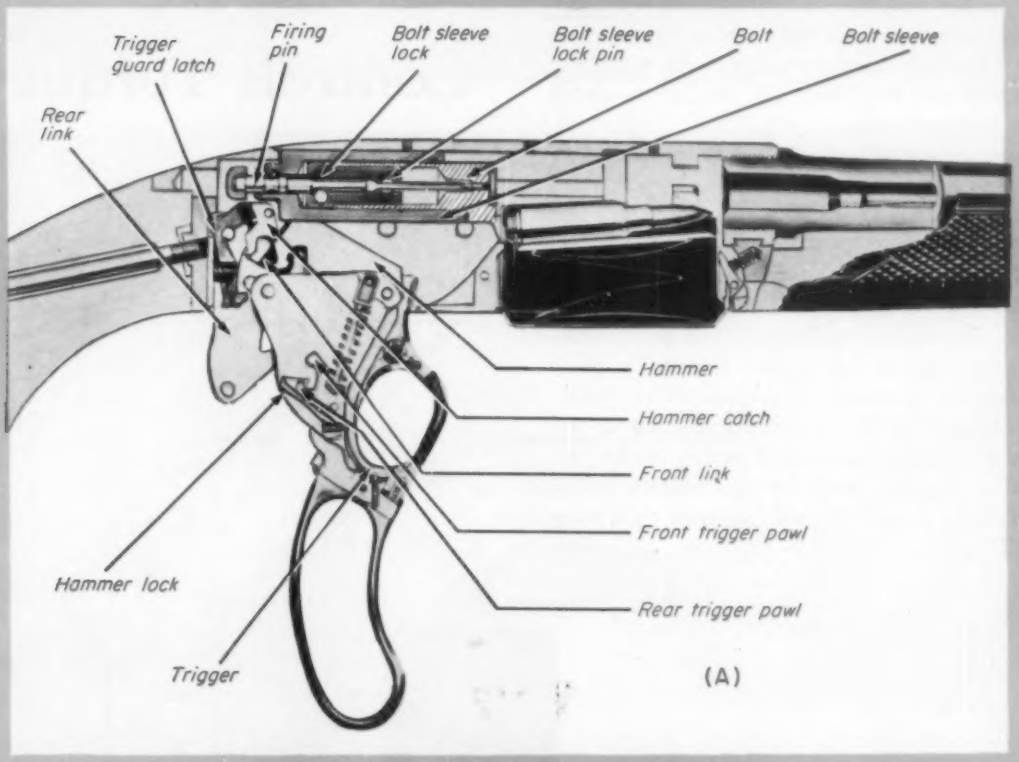
Lever and trigger rotate as unit through 60 deg stroke, to unlock bolt, eject cartridge case and cock. Initial forward rotation of lever operates a safety latch for locking the hammer to prevent firing; further travel rotates the bolt 60 deg, freeing bolt from breech lock, and breaks the cartridge seal. As lever is fully rotated, bolt and cartridge are retracted and cartridge cases ejected; the hammer has been carried back to the cocked position, and a new cartridge inserted into the chamber. As lever is closed, bolt advances to engage cartridge. After bolt reaches end of stroke, further lever travel rotates bolt to engage breech lock. As lever is completely closed, as shown, trigger guard is seated, and safety latch released, leaving pawl (or "sear") to hold hammer. Pulling trigger releases pawl, sending hammer against firing pin.

Bolt is rotated and reciprocated by two links; cam slot in rear link varies the leverage. Length of lever stroke could be less than 60 deg, but leverage would be sacrificed. No relative movement occurs between bolt and bolt sleeve when bolt is rotated. A pin travels in helical groove of bolt sleeve lock, engaging bolt and sleeve; thus, when bolt sleeve lock is initially reciprocated, bolt rotates.

In earlier design, no bolt sleeve lock was used, front link being pinned directly to bolt sleeve. The distance traveled by bolt sleeve to rotate and retract the bolt would have required longer receiver.

To eject the cartridge case at an acute angle, the unlocking rotation of the bolt positions the bolt lug (holding the spring ejector) at 60 deg from the vertical in line with the ejection port. Clean port (no openings to admit foreign matter when action is closed) is achieved by placing port sufficiently to rear of barrel face.

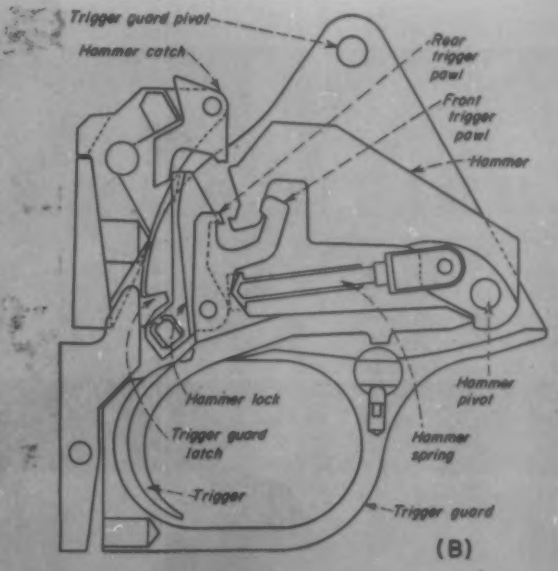
Rifle weighs 6½ lb.



Trigger rotates with lever, requiring a safety mechanism to prevent firing when action is open. On being opened, the finger lever retracts the trigger guard latch, releasing the trigger guard to rotate with the lever. The trigger latch simultaneously actuates the hammer lock and catch; lock engages the hammer if the hammer is cocked. As action is fully opened, hammer lock keeps hammer engaged.

Should the hammer be uncocked as lever is opened, the hammer is cammed back first by the trigger guard and then by the retracting bolt sleeve to the position shown in A; there the hammer is locked by the hammer catch. As lever is completely closed, the guard latch is pushed forward retracting the hammer lock and catch.

Should trigger be pulled while action is open, the hammer is engaged by the rear trigger pawl on closing. By pulling the trigger, the hammer is released from rear pawl and engaged with front pawl which prevents firing. In the ready fire position shown at B, only the front trigger pawl holds the hammer.

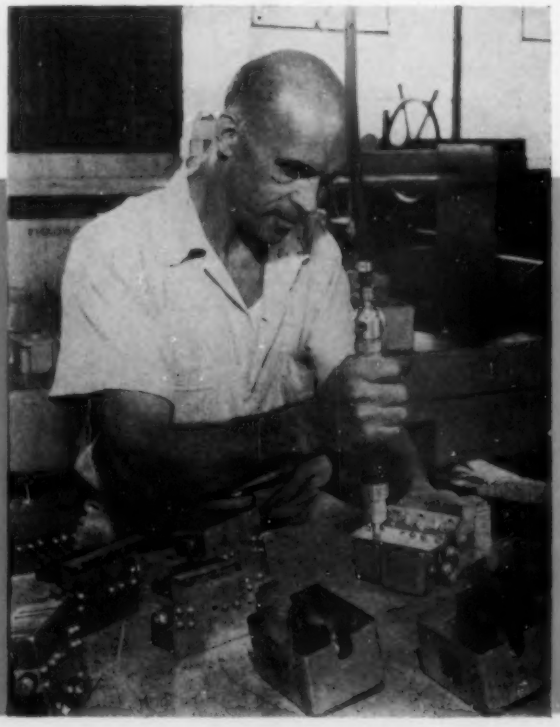


Magnetic One-Shot Clutch Controls Torque in Power Screwdriver

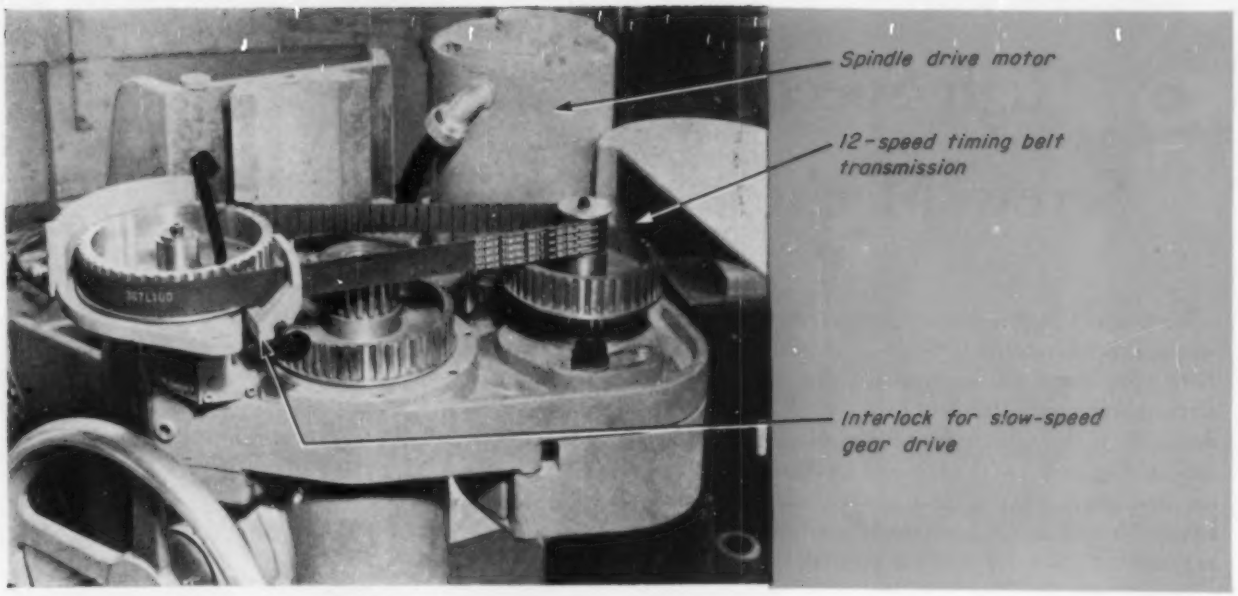
Power drivers for threaded fasteners have used one of two methods for driving fasteners to predetermined torque values. An air motor can drive the screw until the motor stalls, with the stall point adjusted by varying the air pressure. Above 500 rpm the flywheel effect of the motor parts results in inconsistent tightening of screws.

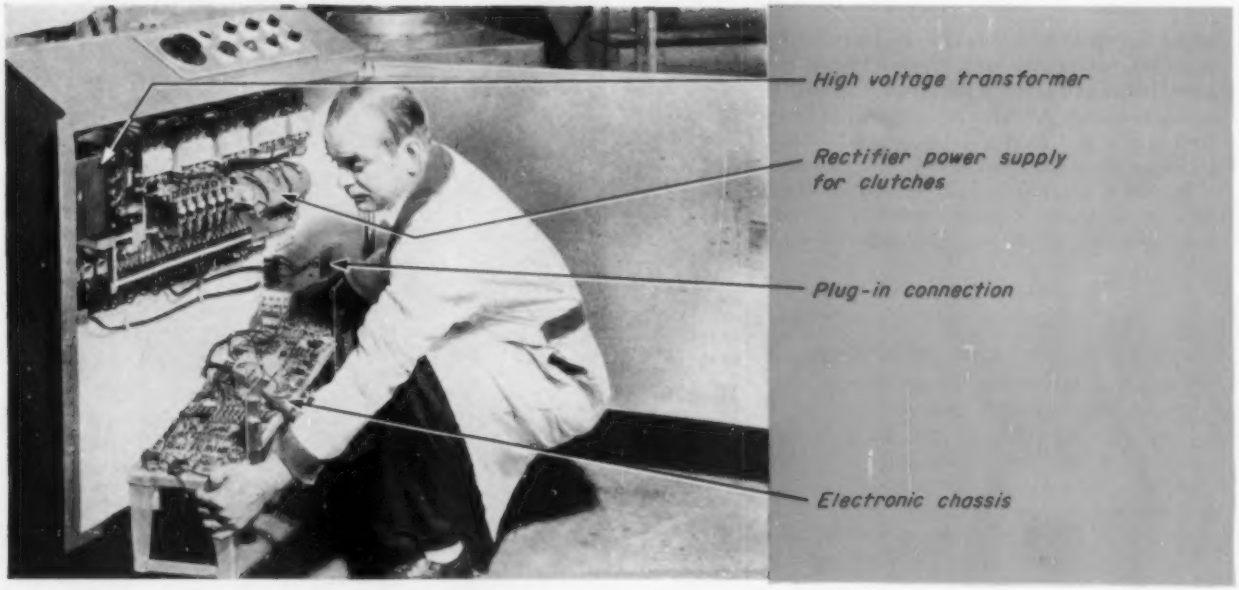
The second method uses a mechanical clutch which disengages when the desired tightness has been reached, but (1) final tightness is dependent on the judgment, skill and reflexes of the operator; (2) clutch disengages only momentarily when full tightness is approached, and immediately re-engages giving rise to a ratcheting action; and (3) the ratcheting damages screws and bits, wears the jaws of the clutch and can be extremely noisy.

The Chicago Pneumatic Tool Company recently announced a new solution to this problem in which the mechanical clutch is replaced by a magnetic type using an Alnico V permanent magnet. This clutch disengages fully the instant proper torque is attained, and stays disengaged until the screwdriver or nut runner is removed from the work. The human element in determining proper fastener tightness is removed entirely from the driving operation. The clutch jaws remain separated, eliminating objectionable ratcheting or impacting action. Most fasteners must be tightened to 80-85 per cent of breaking load, for which clutch can be set; thus, failures caused by under or over tightening are avoided.



OPERATOR DRIVES every screw for these filters to desired tightness with a new air driven screwdriver. New magnetic clutch design makes tool bits last twenty times longer and increases life of clutch jaws. Also, damage to screw heads and surface finish of products is diminished and objectionable noise of impacting type clutch is avoided.





Tracer head (upper left) is a disk, with a diameter equal to cutter diameter multiplied by the reduction ratio—10:1 in this illustration of a template for a steam turbine blade section. The finished template is shown mounted on the work table.

In preparing layouts a dimensionally stable tracing cloth and conventional drafting instruments are used; the conductive line (a commercial silver ink rather than India ink) can be positioned with an accuracy of 0.005 in. A 10:1 ratio will thus reduce the drafting error to 0.0005 in.

Pick-up at the reduction side of the ratio bar is capable of following within 0.0002 in. With a 20:1 reduction small parts are produced with a maximum error of 0.0004 in. when normal cutter and machine errors are added to control errors.

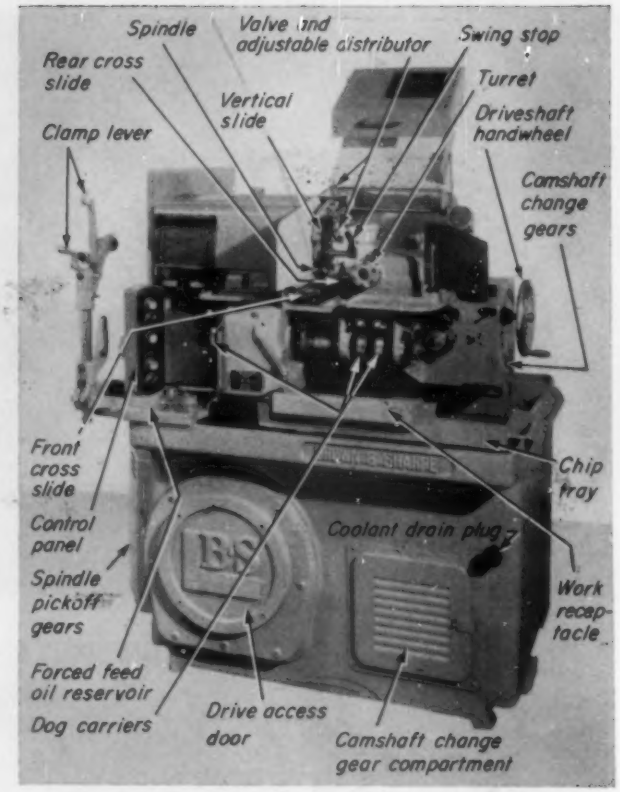
Requirements for rapid machining of small-size pieces imposed unusual problems in the range of feed rates and cutter speed. An adjustable transformer on the control panel permits the operator to adjust speed of table rotation from zero to 0.8 rpm. For irregular shapes, cutting speed must be manually adjusted depending on the radius from center and rate of rise of contour.

To handle both milling and grinding operations called for spindle speeds ranging from 48 rpm to 11,500 rpm, with all speeds designed for continuous, heavy duty. Speeds from 320 to 11,500 rpm are provided by a timing belt transmission; a separate gear drive is used for lower speeds with an interlock preventing belting when gears are in mesh.

Located at the operator's position, the control panel in the top of the electrical cabinet is convenient and simple in layout. High voltage transformer for the spark-gap, rectifier power supply for the reversing clutches, motor starters and other control components are permanently mounted inside the cabinet. The complete electronic chassis is designed as a plug-in unit; all terminals and connections are on top of the chassis; tubes and other components are underneath.

High Speed Screw Machine

To provide higher surface speeds on small diameter work, a pre-loaded ball bearing spindle designed for 7200 rpm has been incorporated into the Model 00 screw machine manufactured by Brown & Sharpe, Providence, R. I. No spindle bearing adjustments are necessary, aiding close tolerance work. Plastic cones mounted on steel shell give efficient spindle reversing clutch; cones give low inertia, and steel frame has low thermal expansion. Chains are used for positive spindle drive.



Control station has jog button to actuate electromagnetic clutch on driveshaft, replacing mechanical clutch. Chip tray was enlarged and made more accessible by removing front support casting; right rear support was redesigned to carry greater load. Drive gears, chains and bearings are splash-lubricated from oil reservoir in machine base. All other components are forced-feed lubricated by a system that reaches 14 more points than previous model, including turret slide ways, clutch and plunger.

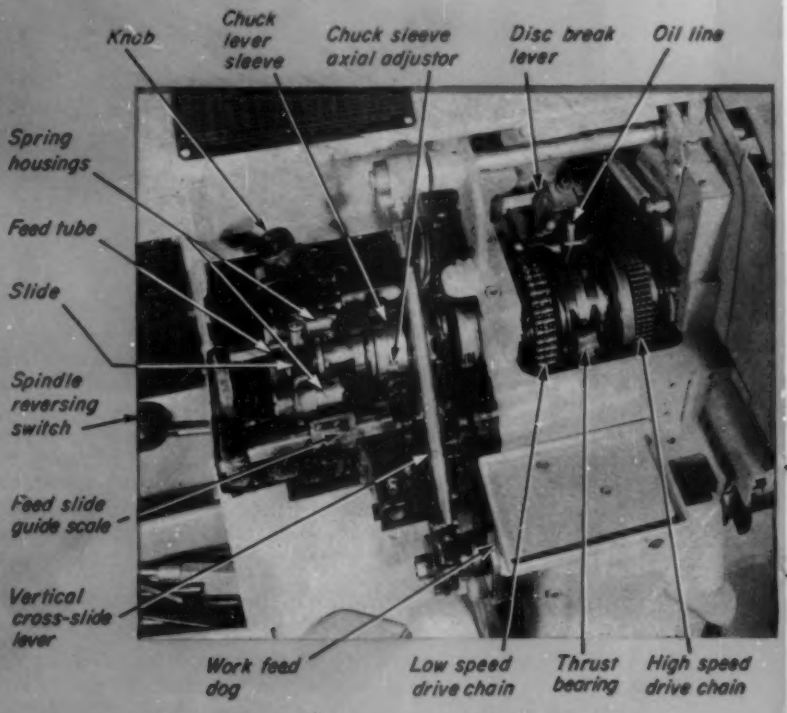
Spindle is supplied coolant through valve and adjustable distributor; the coolant drains through chip tray perforations to reservoir below. Drain plug aids coolant changing; after plug is unscrewed, cylindrical inner end retards oil flow until plug is withdrawn. Motor and drive mechanism are accessible from front or rear of base.

Two cylindrical cams (not shown) simultaneously open chuck in spindle and advance slide, pushing stock forward. Feed fingers in front section of spindle maintain grip on stock. Swing stop at front of spindle is cammed down to block stock advance beyond predetermined point. After stock is advanced, cams close chuck, return slide and carry stop clear of work.

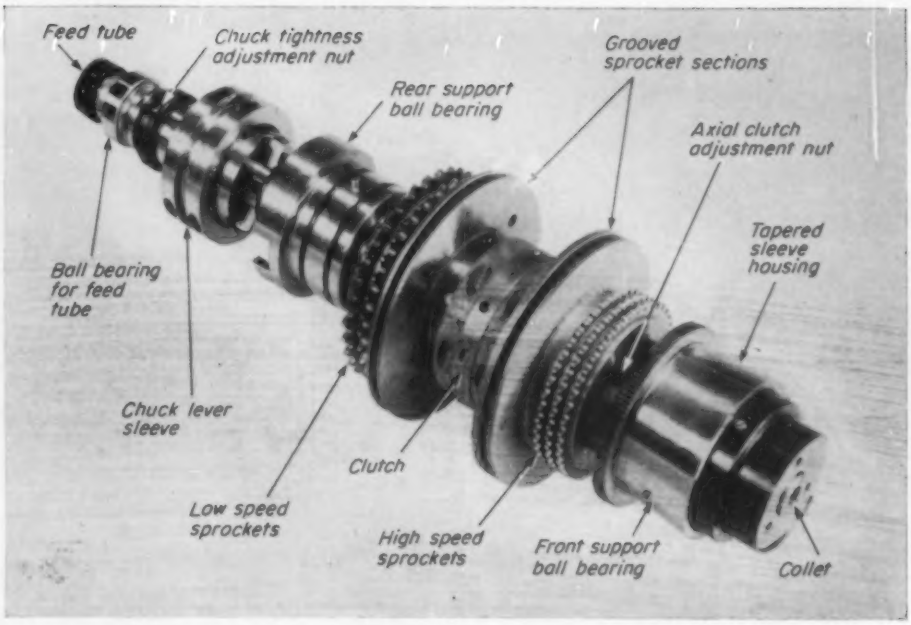
Knob is used to adjust amount of stock travel by positioning an element along a pivoted lever; distance element is from pivot determines distance slide moves. Springs compress to prevent damage to feed tube if advance meets interference.

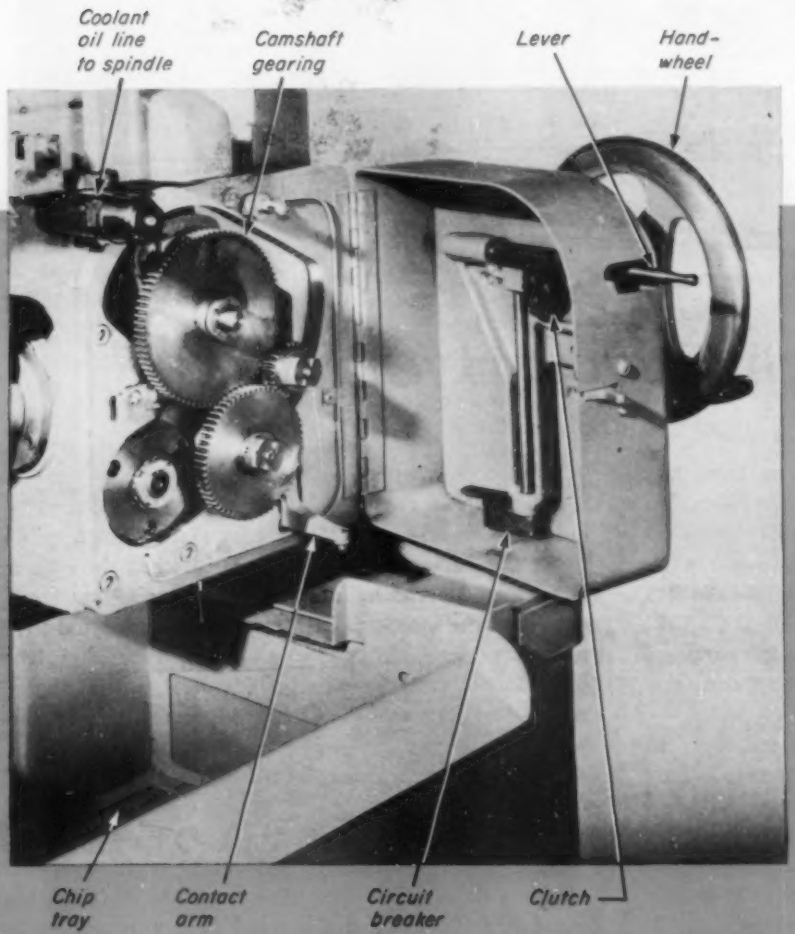
Spindle is driven by ¼ pitch, triple roller chain, to minimize pulsations (see "Eliminating Pulsations in Chain Drives," July 1955 page 168). Spindle direction for high speed turning is changed by reversing switch; switch changes direction of main motor, with pick-off gears so set-up that drive shaft rotation remains unchanged. Reversing switch cannot be thrown should gears be improperly positioned; a shoe prevents placing improper gear on stud.

To hold the workpiece stationary for milling or cross-drilling, a brake disc can be applied to spindle when clutch is in neutral. Previously, slow speed sprocket had to be blocked. Chain tension is adjusted at rear of machine by moving a sleeve allowing spring to force idler sprocket forward.

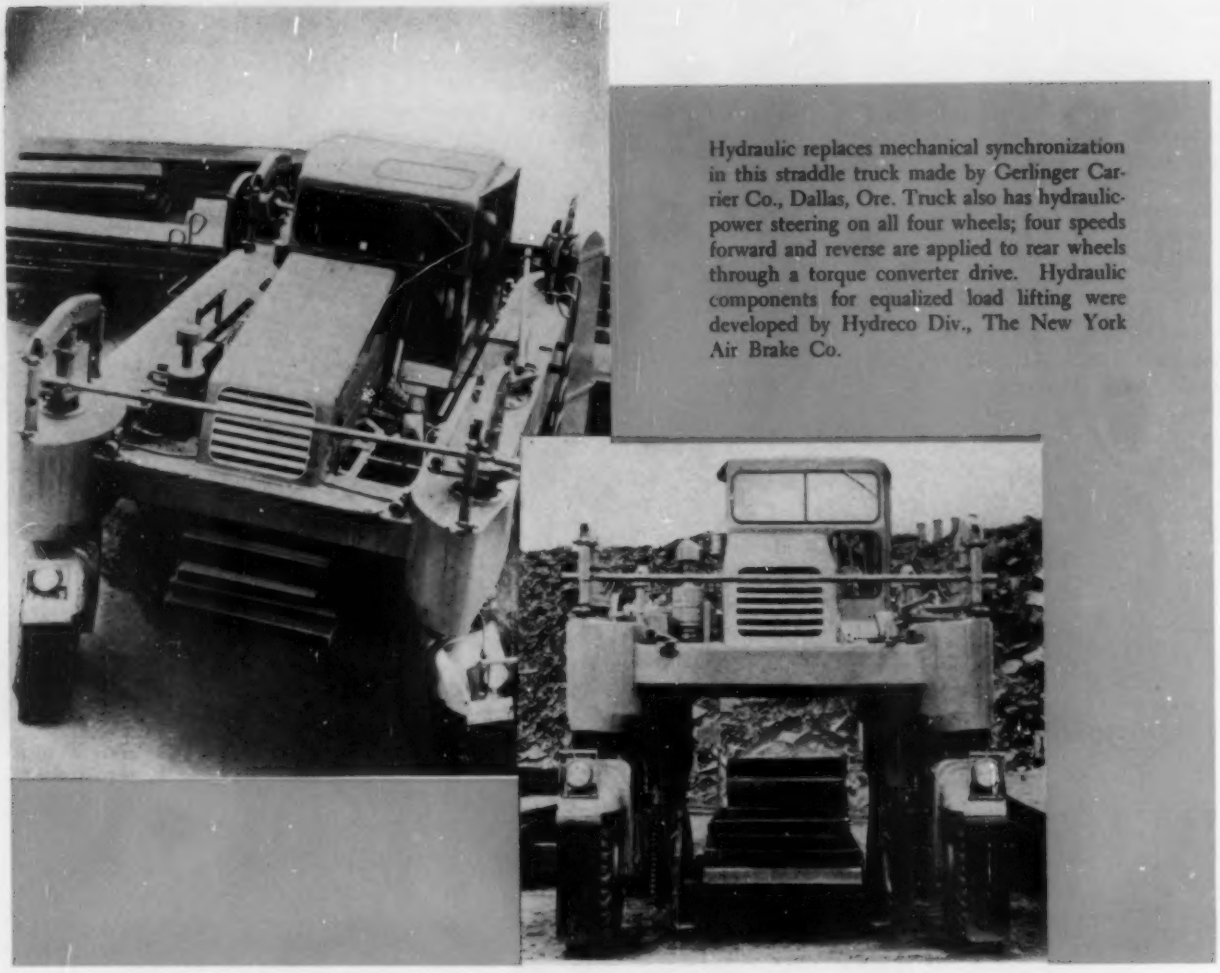


Ball bearings replace roller bearings of previous spindles; reduced bearing friction permits higher speed. Pre-loading the ball bearings allows for minimum bearing clearance in the spindle, and requires no bearing adjustments. Threads used to axially adjust clutch previously were mounted on roller bearings and supported sprockets; now sprockets are directly supported on outer race of ball bearing. To carry increased loads created by higher rotational speeds, diameter of cones has been increased. Sprocket sections serve as flywheel for smoother chain drive; grooves aid dissipating heat. Collet is held by single nut on spindle nose; gripping is adjusted by nut on spindle.





Handwheel manually cycles machine during set-up. When case door is closed, lever can be brought forward to engage clutch to drive shaft. Lever swings circuit breaker clockwise to permit contact arm to spring up, opening the control circuit to prevent power rotation of drive shaft. Likewise, the control circuit is opened whenever door is opened.



Hydraulic replaces mechanical synchronization in this straddle truck made by Gerlinger Carrier Co., Dallas, Ore. Truck also has hydraulic-power steering on all four wheels; four speeds forward and reverse are applied to rear wheels through a torque converter drive. Hydraulic components for equalized load lifting were developed by Hydreco Div., The New York Air Brake Co.

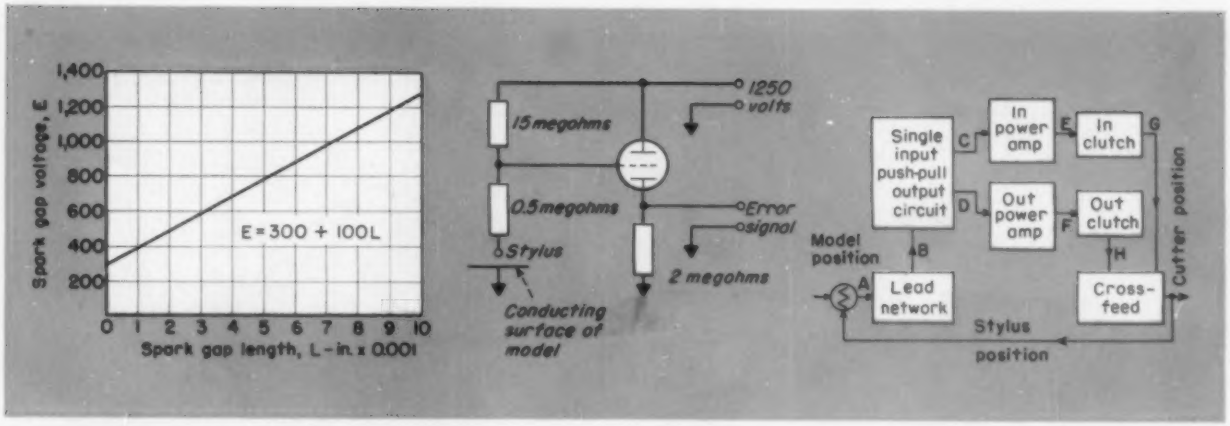
Lift is Synchronized Hydraulically

Standing high on its wheels this straddle truck carries steel or lumber on two lift shoes beneath the undercarriage. Two hydraulic cylinders are used to swing the lift shoes under the load, and lifting is accomplished by means of additional hydraulic cylinders located near the wheels in the corners of the truck. Each lift shoe is raised by two hydraulic cylinders; all four lift cylinders should maintain equal rise even when an unbalanced load is raised.

In common practice the shoes were geared together mechanically by means of heavy bell cranks. This mechanical coupling required sturdy shafts and bearings; wear and maintenance problems made this type of synchronism expensive and unwieldly. Hydraulic synchronism substituted four inexpensive hydraulic gear motors and suitable tubing connections, providing precise matching of piston movement under all load conditions.

As shown in the diagram, flow from the bottom of each double-acting cylinder passes through a pilot operated check valve and then is metered through a fixed-displacement hydraulic gear motor. Flow from the four gear motors is manifolded and connected to a manually operated, four-way, spring-centered valve. The four gear motors are identical, their shafts coupled so that the oil discharged or received by the bottom of each cylinder is the same. The upper sides of the cylinders are manifolded and connected to the four-way valve.

Flow from the main pump (at the bottom in the diagram) is controlled by the operator through the Hydreco four-way valve. To lift the load the valve spool is shifted to the right and high pressure oil is divided equally by the four motors. Each piston is



Milling machine for three-dimensional work has a headstock at the center of the bed, and a carriage and tailstock at each end. The left-hand end carries the model on an arbor and the tracer head; the right-hand end carries the work in a chuck and a cross slide with a milling head. This cross slide is driven by magnetic clutches controlled by the tracer head. Longitudinal feed for both carriages is provided by a common drive.

The tracer (lower left) is a metal disk which ordinarily is precisely the same diameter as the milling cutter. The finished turbine blade shown in the illustration below required only 16 min. to machine complete including fillet and platform of the root section.

Non-contacting tracer system is designed to keep the tracer point always at such a distance away from the conducting model that the spark-gap potential is maintained constant. This system has high sensitivity, high speed of response and a large output signal; as shown in the curve, a change of 0.001 in. in gap produces a change of the order of 100 volts in spark-gap potential. Spark current is limited to a safe value by a series resistor so no harm is caused by contact with the stylus, and arcing is not destructive to stylus or model.

Circuit used to produce the spark and the error signal is relatively simple. The same signal is delivered when any portion of the stylus approaches the model, and no mechanical movement is involved in generating the signal. As shown in the block diagram, signal outputs of the "in" and "out" power amplifiers are of opposite polarity, and their variations are controlled by the length of the spark gap. Amplifier outputs control two counter-rotating electromagnetic clutches each geared to drive the cross slide in the opposite direction.

Each clutch slips continuously; the one with greater energization determines the direction of motion through its own independent drive to the cross head. The drive thus is free from backlash. Result is that variations in spark length (and cutter position) are held closer than the best milling tolerances.

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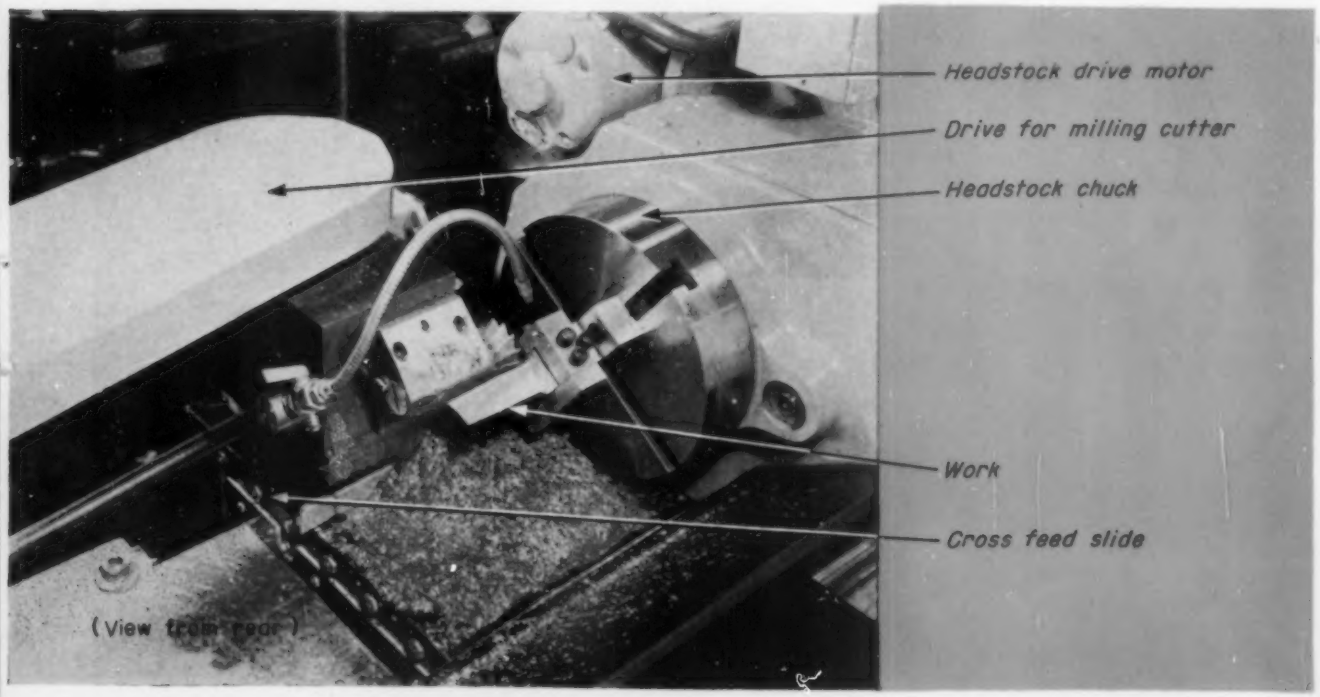
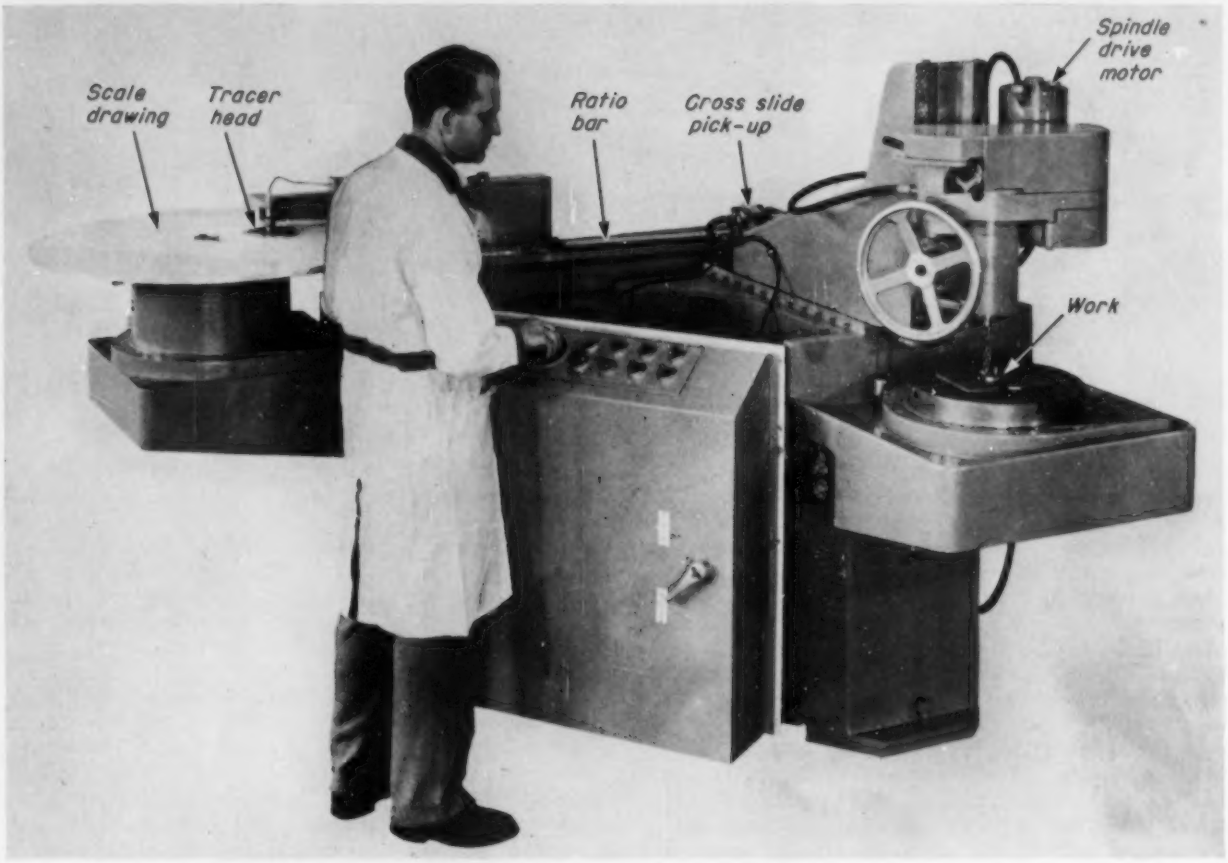
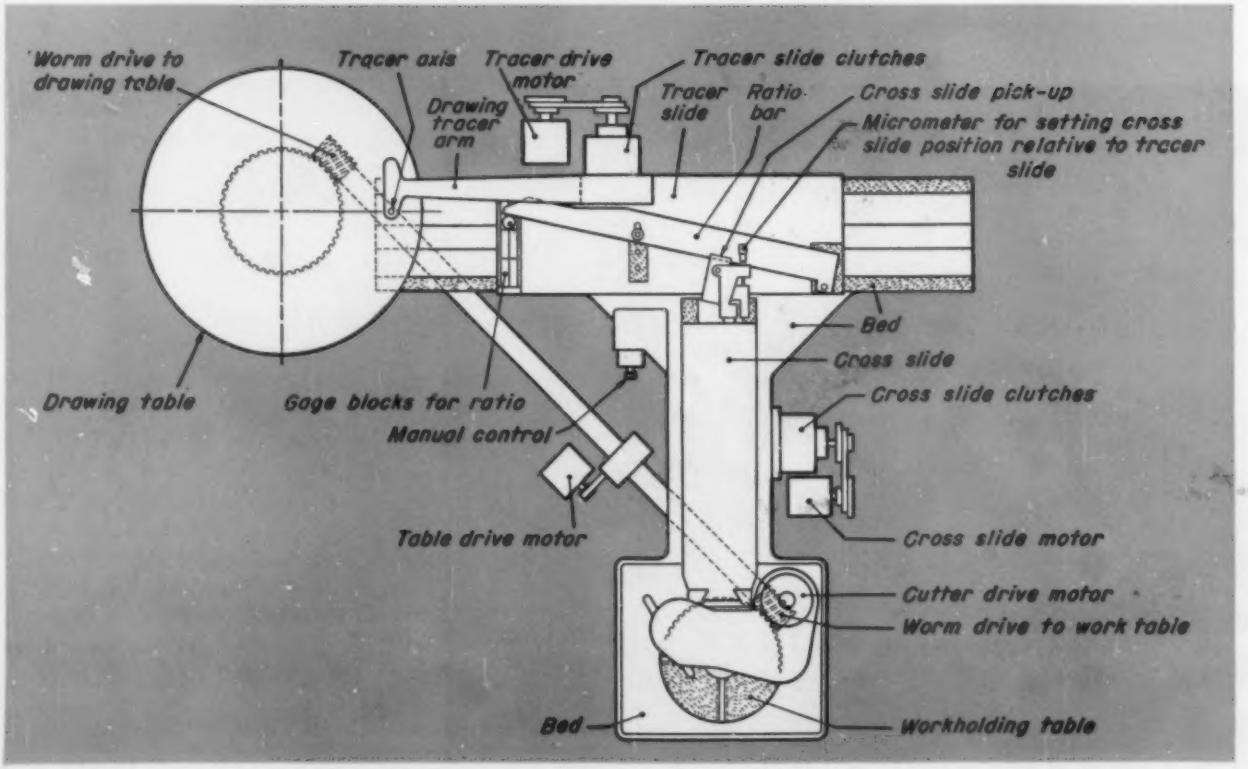
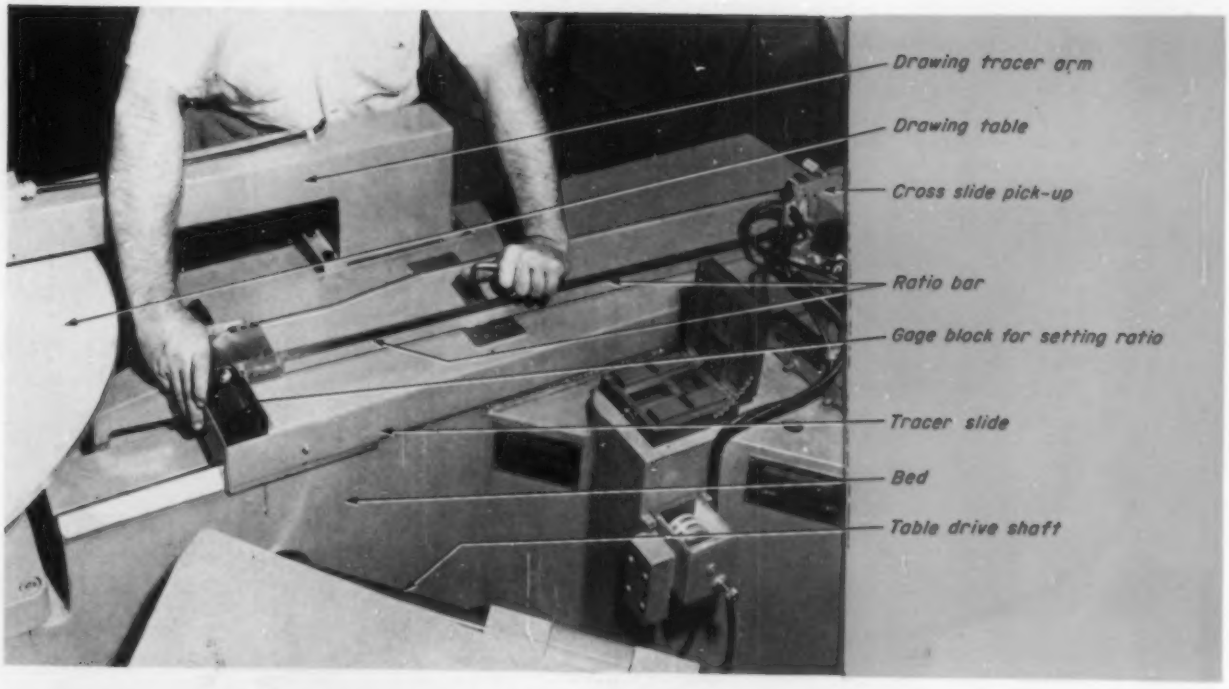
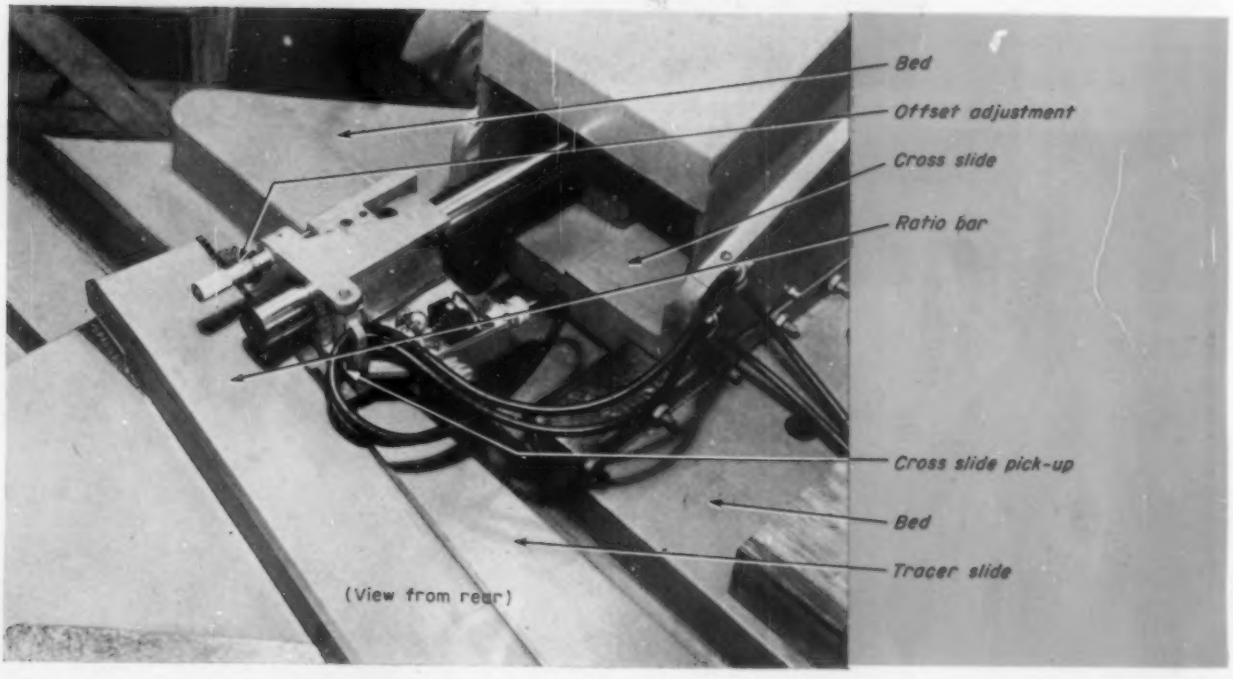



Scale drawing
Tracer head
Ratio bar
Cross slide pick-up
Spindle drive motor
Work


Worm drive to drawing table
Tracer axis
Tracer drive motor
Tracer slide clutches
Drawing tracer arm
Tracer slide
Ratio bar
Cross slide pick-up
Micrometer for setting cross slide position relative to tracer slide
Bed
Cross slide
Cross slide clutches
Drawing table
Gage blocks for ratio
Manual control
Table drive motor
Cross slide motor
Cutter drive motor
Worm drive to work table
Bed
Workholding table





In addition to duplicating a three-dimensional model, the same spark-gap transducer makes possible this template and cam machine (left) which produces a two-dimensional part from a scale drawing. Bed is in the form of a right angle; at the outboard end of the long leg is the rotary drawing table; at the end of the short leg is the work table. Forming a hypotenuse is a common drive shaft synchronizing the two tables through non-backlash worm gears.

Two tracer drives are used: one causes the tracer point to follow the edge of a conductive line on a drawing as the table is rotated, thus moving a slide carrying a ratio bar; the other tracer point follows the reduced motion of the ratio bar and moves the cross slide carrying the cutter.

Reduction ratio can be adjusted from 5:1 on up by inserting gage blocks as shown under the ball at the end of the ratio bar. At the other end of the ratio bar (looking from the rear in the illustration) is the pick-up for the cross slide. Micrometer adjusts relative position of tracer head and cutter; cross slide can be backed away from center of work in making roughing cuts.

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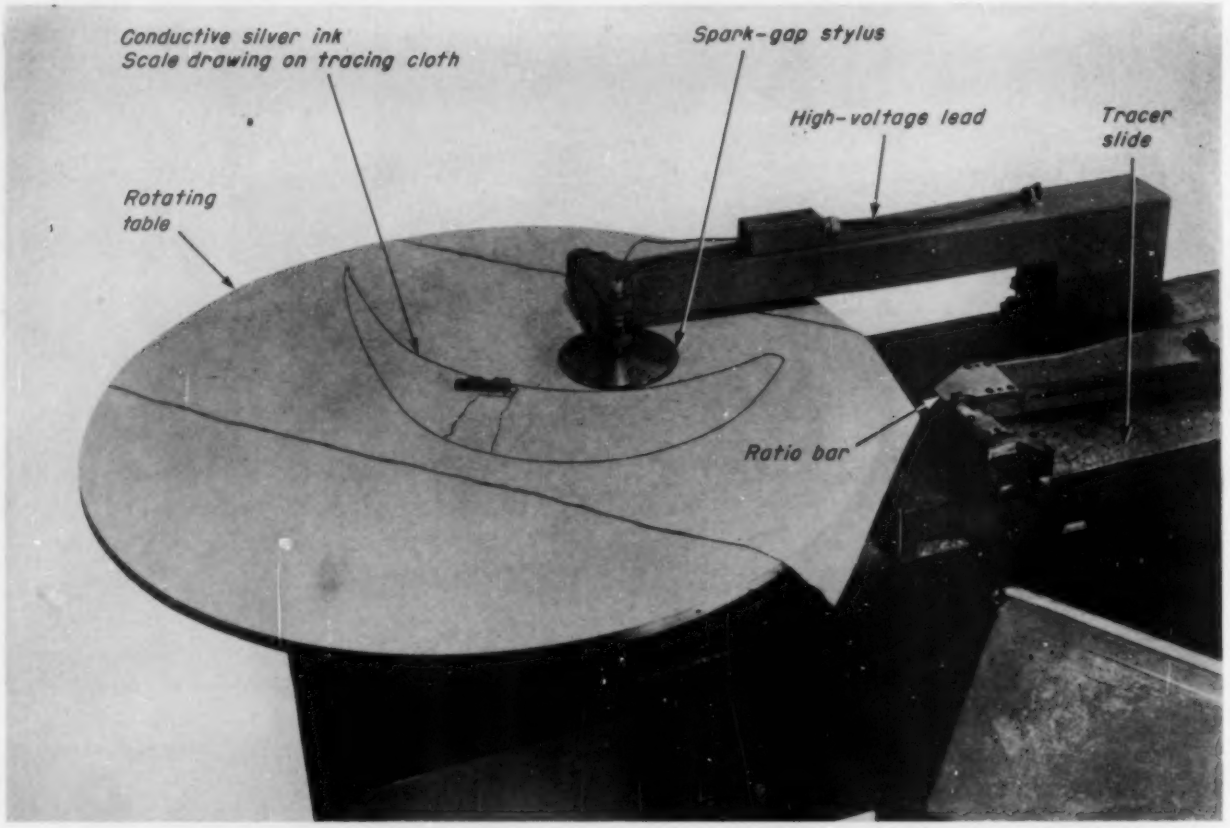
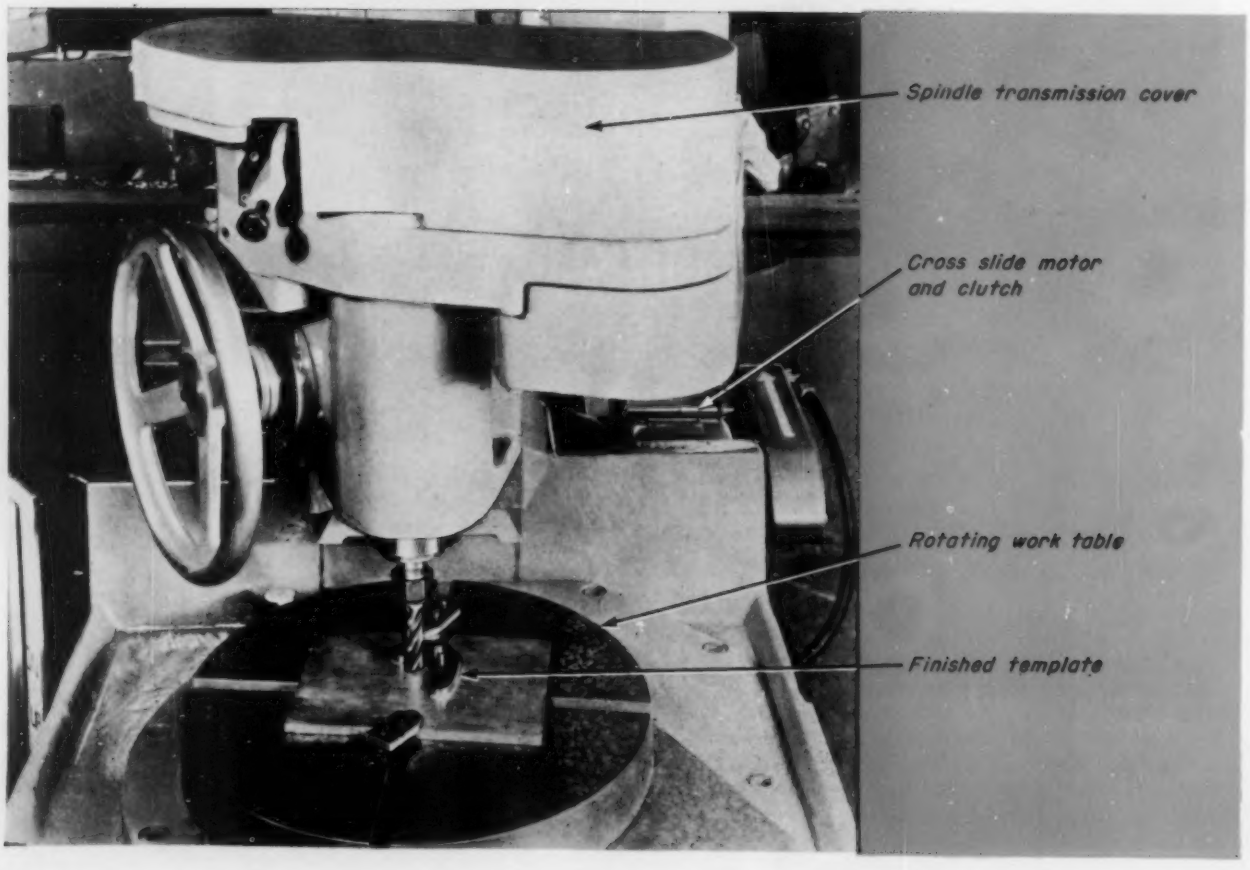
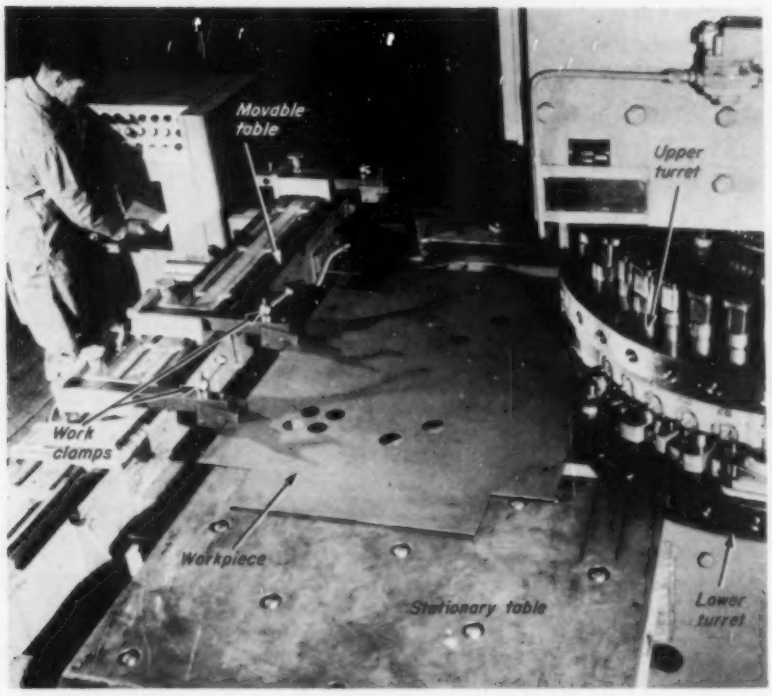
Spark-Gap Tracer Control (continued)

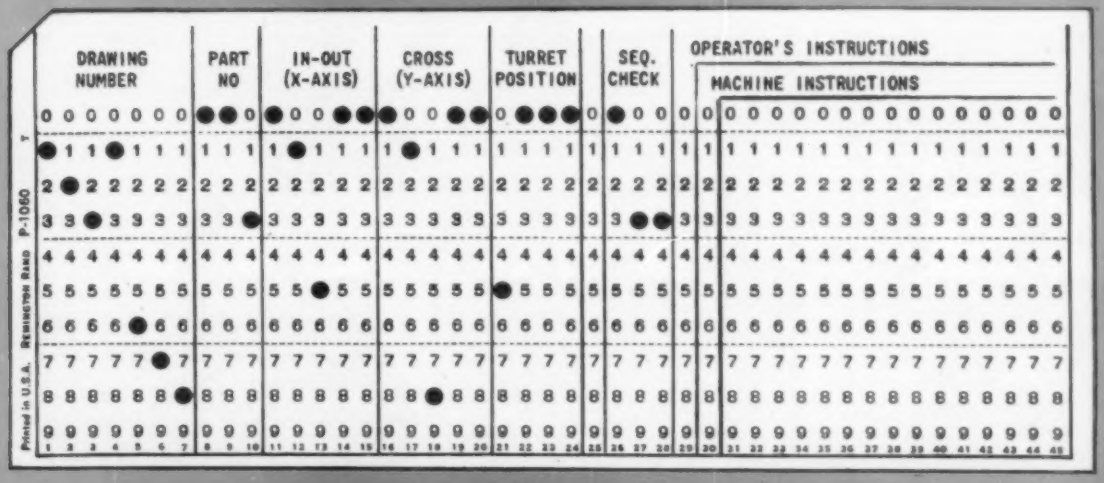






Workpiece is clamped on table, and cards hand fed into director slot. Operator pushes "control on" button, card reading is initiated, and appropriate motions directed by selsyn system; all three motions position simultaneously. Feed drives run at pre-set top speed until reaching given distance from the desired position, then motors operate at a speed proportional to the distance from the desired position. After motions are completed and upper and lower turrets locked, punch cycle is initiated; simultaneously, card is fed to reader for next cycle. Single motor serves separate chain drives of upper and lower turrets.

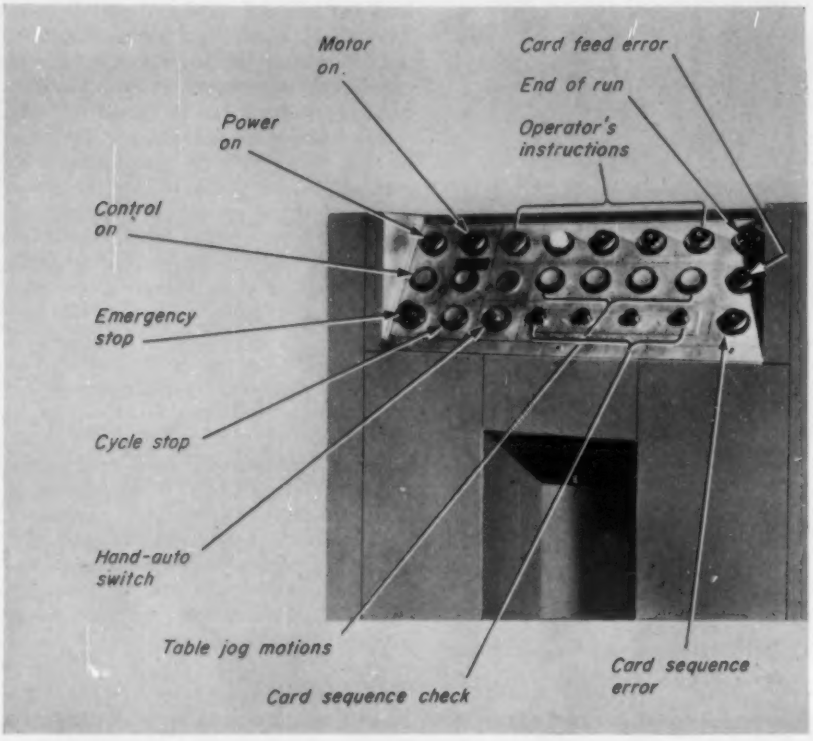
Large masses of the two turrets required stabilizing—chain drives were tightened to reduce whipping action, and turret was decelerated at a point farther out from desired position. Clamps shown have been replaced by smaller spring clamps which can fit between closed turret jaws; now punches can be made closer to outer edge of work piece, without having to reposition the clamps. Table and turret speeds were determined on basis of backlash control; gear wear was an additional factor in limiting the speed.



Two types of control system were considered—tape and punch card. Contour following was not applicable; a templet for the information needed would be difficult to prepare. The punched card system was selected for flexibility—an individual card can be added or subtracted from deck or punched for quick last-minute changes. Moreover, by using an uncoded decimal system and punching the information in digital form, the cards can be easily read by operator. On cost basis, punched card system was also preferable—a standard unit was available which could read all information simultaneously and store the information in the reader, eliminating the need for additional storage elements.

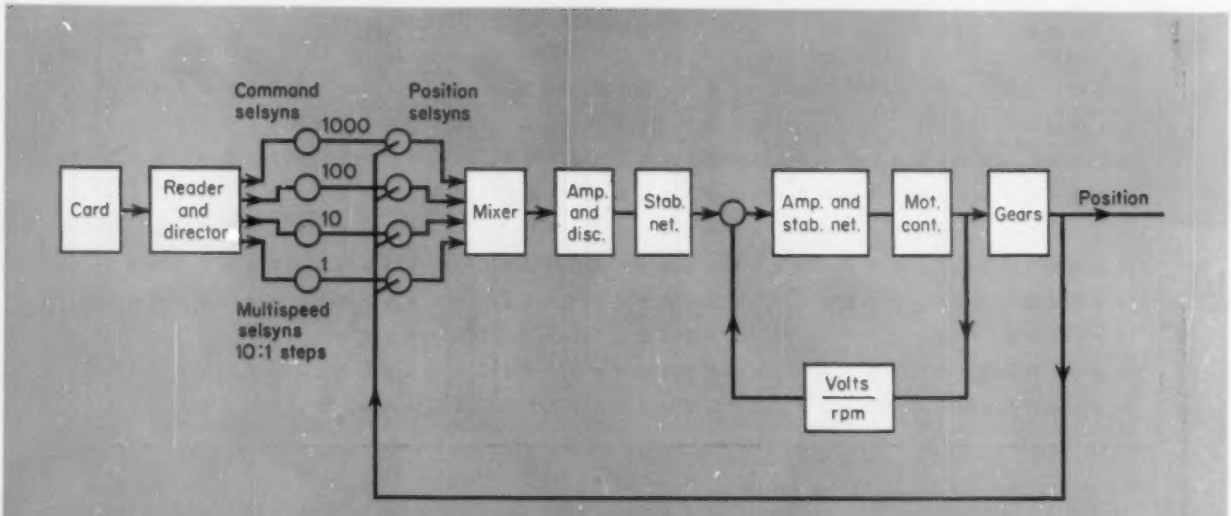
Cards are prepared from plan chart indicating required functions; information on card is punched by standard key punch. Each digit in the position columns—in-out, cross and turret—may be represented by a selsyn. Sequence check is safety feature that protects against work interfering with clamps. Machine instructions include "position do not punch" (for loading, unloading or clamp changing), "position and center punch"; operator's instructions include "move clamps" or "rotate workpiece". By indicating part number, one card deck may include several parts; experience, however, shows that greater speed and ease is accomplished if separate decks are used for different parts. Operations necessary for particular applications can be indicated in last fifteen columns of card. (continued on next page)

Turrent Punch Press (continued)



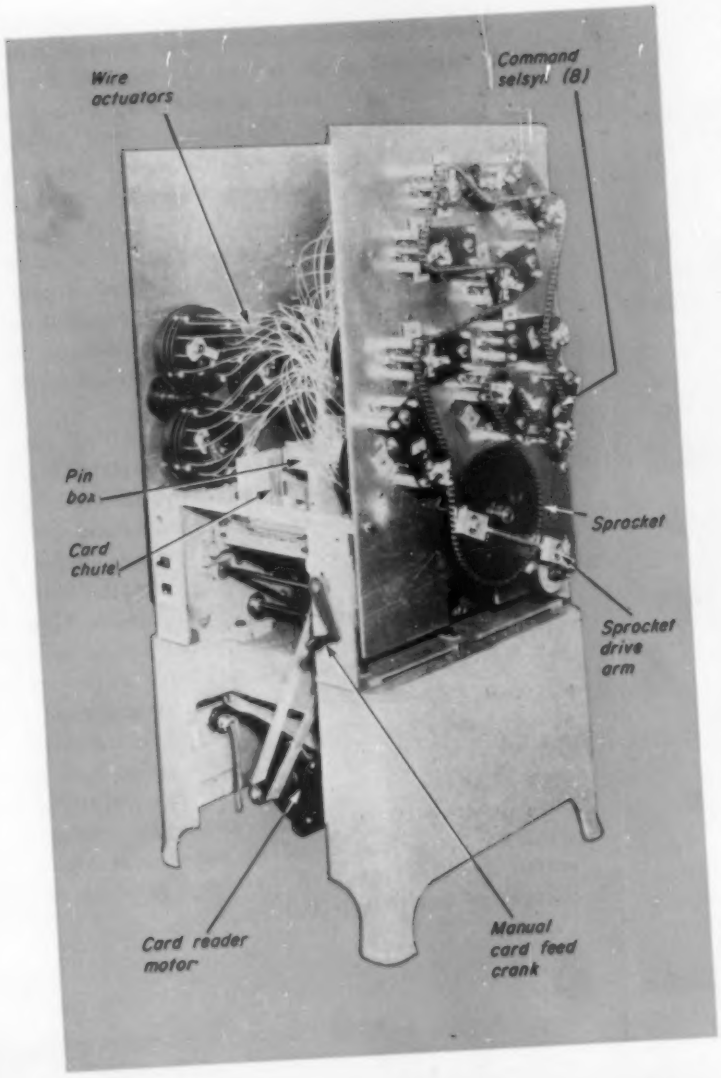
Control panel provides conventional start and stop buttons. Table can be jogged in any of four directions by 4-button array. Card sequence is monitored by indicating light; should light indicate, operator manually re-arranges cards and resets for sequence by pushing appropriate buttons. Buttons actuate stepping switch in director to correspond with card sequence number.

Card feed error light indicates defective card reading, and machine is stopped. Machine can be set for hand or automatic control by panel switch. During automatic operation, by switching to "hand", the table and turret may be manually positioned to any desired point; re-switching to "automatic" returns the table and turret to previous position. Return is accomplished by action of error-sensing relays. Once press is back to previous position, the automatic cycle is followed through. Five lights are used for operator instructions—lights signal in sequence to aid operator in checking master card.



Command selsyns are angularly positioned according to the punched information. Position selsyns, one for each command selsyn, are geared directly to a controlled machine member—the table or turret. Command and position selsyns are electrically connected so rotor voltage of each command selsyn is proportional to the angular position between the respective command and position selsyn. Selsyn signals are combined in the mixer circuit to give a single signal of proper sense and magnitude for each motion. This signal is amplified and discriminated; positioning is continued until amplitude is zero.

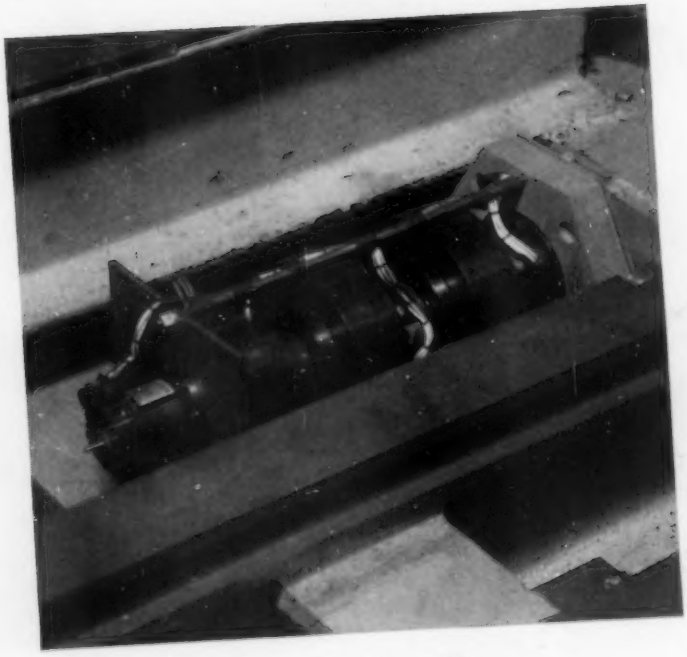
An error-monitoring circuit checks the discriminator output of each motion. When all three outputs diminish to a pre-set level, relays signal start of punch and card feed cycles. Motor control is by means of half-wave thyratrons, fired in the positive half cycle of the supply voltage with the point of fire controlled by the selsyn signal. Motor armature voltage is fed back to improve control stability, this voltage being a true indication of speed at moment of firing.



Director unit, interior view. Card reader is driven by continuously running motor; cycle is initiated by solenoid-actuated clutch, and stopped by a cam action. Card feeds into pin box and is read by mechanical pins; pins lock, storing card information. Meanwhile, an arm riding on a cam moves the sprocket wheel. Through the positive chain drive, the selsyns are carried slightly more than 1 rev past zero. On release of reader pin lock, push wires inside guide tubes are actuated, transferring motion to appropriate selsyn stop-pin. (Stops are located at ten equal points throughout a selsyn revolution, representing digits 0-9.) The arm returns wheel to original position, the selsyns following by spring return until striking stop set from card information. The selsyns are de-energized and motor loop contactors opened during this interval, so motion exerts no influence on rest of machine.

The number of selsyns used depends on the length of travel and accuracy required. Four selsyns are used to direct each of the two table motions—the selsyns representing units, 10's and 100's and 1000's. The units selsyn, positioned to one hundredth of a revolution, fixes the accuracy—0.010 in. The 1000's selsyn carries the complete number; each selsyn representing the smaller parts of a number reacts on those selsyns carrying the larger parts of the number. This is effected by 10:1 gearing between selsyns representing small parts of number and latch boxes carrying pin stops for higher number selsyns.

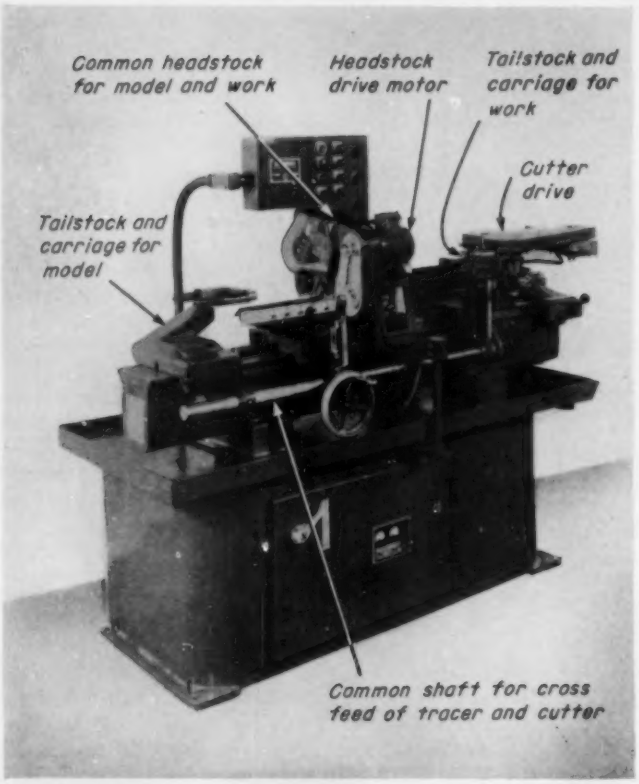
To insure correct phase sense of the selsyn signal as the desired position is approached, the mixer circuit was designed so higher speed selsyns would make no more than one revolution while synchronizing. The slow speed selsyn has control until close to its correspondence; then the control is transferred to the next higher speed selsyn—a process repeated until the unit selsyn gains control and the system reaches correspondence. Transfer is accomplished by a system of linear and non-linear resistors.



Position-sensing slesyn pick-up units—one set shown mounted on press—are driven by the table and turret drive shafts. As each command selsyn represents a decimal part of a number, the corresponding position selsyn represents a decimal length. In order to keep drive backlash inside the servo loop, position-sensing selsyns usually are mounted directly on the motion, but in this application the selsyns are geared to the pinion shaft that drives the table rack. Hence, some of the backlash is outside the loop, sacrificing accuracy for stability and ease of selsyn installation.

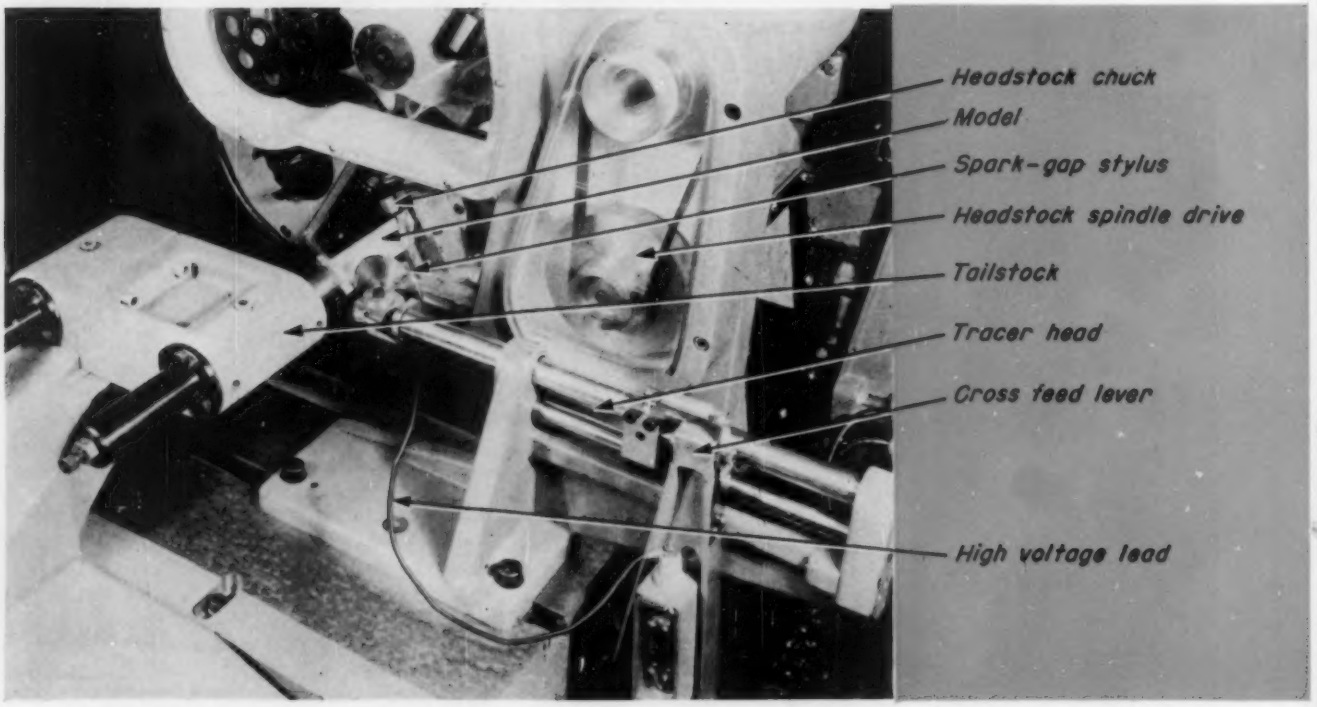
Of the four table selsyns shown the lowest speed unit is geared for 1 rev per 1000 in., the fastest for 1 rev per in. travel. The slowest selsyn cannot make more than one-half revolution over the entire length of travel; otherwise, reversal of signal would occur. In this installation the travel is limited to 500 in. The turret selsyns have no travel limitation because of rotary motion; two turret selsyns are used, set to one part in 10,000. With backlash outside loop, the position should be approached from same direction. To do this, a false signal of constant polarity is used, positioning motion just off desired point. False signal is removed, motion continuing.

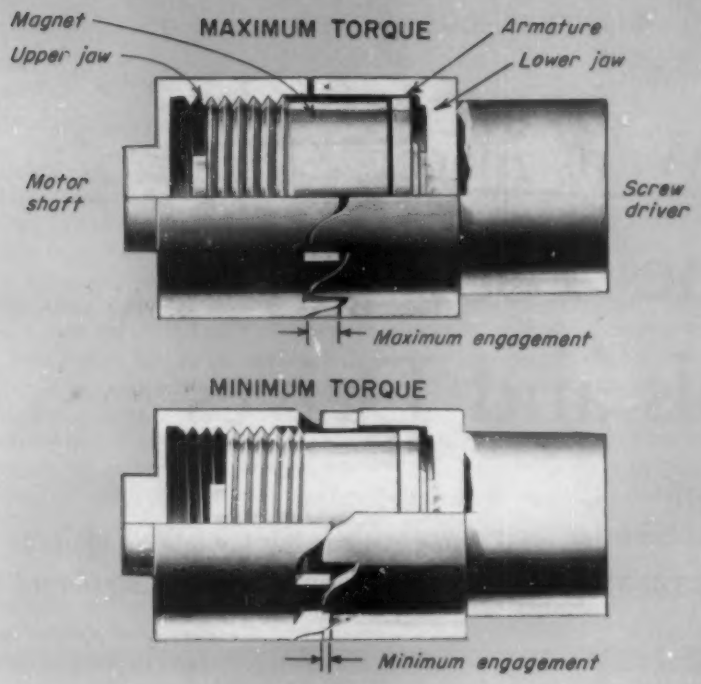
Spark-Gap Tracer Control


Common headstock for model and work
Headstock drive motor
Tailstock and carriage for work
Cutter drive
Tailstock and carriage for model
Common shaft for cross feed of tracer and cutter

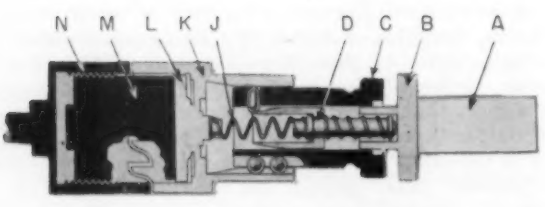
Increased need to duplicate small parts of complex form and shape led to the demand for a tracer control that could operate with little (or no) stylus force, with fast response, and simple enough for application to a relatively low-cost machine. For some three-dimensional parts, such as jet engine blades with airfoil contours, closer tolerances were needed in combination with operating speeds high enough to handle limited production quantities. And, since many two-dimensional contours needed are empirical designs it would be helpful if the tracer system could work directly from a drawing.

Two new tracer-controlled milling machines, developed and manufactured by New England Machine & Tool Co., and marketed and serviced by Pratt & Whitney Div. of Niles-Bement-Pond Co., accomplish these design objectives using an adaptation of the spark-gap principle in which the voltage across a spark gap varies with gap length. This system senses position of stylus in relation to a conductive surface by the potential of a spark gap between stylus and model. A servo system maintains a fixed gap of the order of 0.001 in. between the stylus and pattern or between stylus and a conductive ink line on a drawing. Since the stylus never touches the model, no operating force is exerted on the model, speed of response is high, output signal is large, and the system responds to changes of less than 0.0002 in.

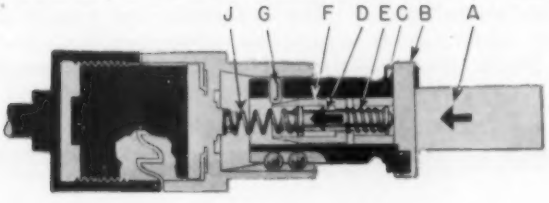




TORQUE SETTING is adjusted by screwing the magnet assembly into or out of the upper clutch jaw. This changes the depth of engagement and the angle of contact of the teeth on the clutch jaws. For maximum torque, clutch jaws are set with maximum engagement illustrated. Torque required to cam the lower jaw out of and away from the upper jaw under restraint of magnet on armature will be high because of the steep angle of contact of the teeth. For minimum torque, magnet assembly is screwed out of upper jaw. With this setting the angle of contact at this point is relatively small and a considerably smaller torque will break the magnet away from the armature. Torque setting is independent of fluctuations in air pressure.



(A)



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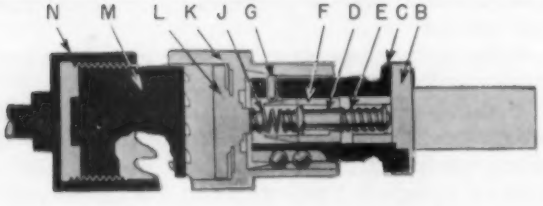


(C)

A.—With no axial pressure on spindle, spring *J* holds latch pin *D* forward. Pin holds clutch pin *B* forward and disengaged from positive clutch jaw *C*. Magnet *M* holds armature plate *L*, keeping lower jaw *K* engaged with upper jaw *N*. In this position all parts rotate except hex drive spindle *A* and pin *B*.

B.—With tool on work, axial pressure is applied forcing spindle *A* rearward, engaging pin *B* with jaw *C*. Drive spindle is thus rotated, driving the screw home. Moving rearward, pin *B* pushes pin *D* to rear, compressing spring *J*. Latch sleeve *F* is prevented from moving rearward by lock pin *G*; spring *E* is compressed.

C.—At desired torque, lower jaw *K* cams out of upper jaw *N* against the pull of magnet *M*. When distance between armature plate *L* and magnet reaches about 0.015 in., magnet pull is overcome and camming throws jaw *K* further forward. The inside taper of jaw *K* lets lock pin *G* be moved outward by tapered sleeve *F* pushed rearward by spring *E*. Pin *G* wedges on taper of jaw *K*, keeping it from engagement with jaw *N*. Thus, jaws disengage instantly at the desired torque and positively lock out of engagement, preventing further torque buildup no matter how long tool is held on work.

D. (Same as A)—With tool removed from work, spring *J* pushes pin *D* forward, disengaging pin *B* from jaw *C*. Latch sleeve *F* also moves forward. Taper on sleeve lets lock pin *G* be pushed in towards axis by taper on lower jaw *K*. Lower jaw moves rearward until armature plate *L* contacts *M*.

A Product Engineering Staff Report

What Users Want in the Design of Machine Tool Controls and Drives

Summary of confidential interviews with production and maintenance supervisors in a representative group of metal-working plants.

To uncover areas of needed improvement in the design of motor drives and components, and electrical, electronic and hydraulic control systems for machine tools, *Product Engineering* editors conducted a planned series of personal interviews with production superintendents and maintenance supervisors in a representative group of plants.

Some were large plants with thousands of machines; some were small with only one machine of a kind. Some worked on tight production schedules where down time was costly; others were building special equipment with long delivery schedules. Plants doing high-precision work were included, as well as a few who worked to wide-tolerances.

Industries covered in these interviews included: Agricultural machinery; aircraft engines, airframe manufacturing, automatic machinery, automotive assembly, automotive manufacturing, business machines, centrifuges, chemical process equipment, communications equipment, electrical controls, electrical manufacturing, electric motors, hydraulic control, hydraulic presses, industrial machinery (heavy), industrial trucks, machine tools, military fire control, ordnance, printing presses, wire and cable.

In this wide range of industries, there was remarkable concurrence on a number of important needs—confirmed even by the plant superintendents in some shops making machine tools.

Since the editors received this information on the promise of complete anonymity—as a means of getting closer to real needs—no sources are identified in this summary. No specific identification can be made, nor can further information than here reported be made available.

Some needs reported here have been or are being met in newer types of machines. But the frequency with which these needs were expressed—even when machines meeting them are available—is a challenge to the machine tool industry as a whole.

The questions asked in each interview pointed the discussion specifically to metalworking machines. Yet, most of the improvements suggested are just as sorely needed in many types of industrial machinery.

Here is a summary of what *Product Engineering* editors were told—just as it was told them, without interpretation, embellishment, criticism or analysis.

MACHINE SPEEDS

There is growing recognition of the need for automatic regulation of machine speed and continuously adjustable drives to obtain faster machining, more uniform surface finish, and less non-cutting time. Torque converters were suggested for the combined advantage of fine speed control and machine protection. Several men mentioned the need for a-c variable-speed motors; another said that hydraulic motors might be a better answer, particularly in a system arranged to provide a constant cutting speed automatically as diameter changed. One user spoke highly of d-c machine drive as a means of obtaining needed speed control.

Higher machine speeds are needed; one user wants a spindle speed of 3,000 rpm on a 16-in. lathe.

To avoid chatter and obtain better finish at high cutting speeds, more rigid frames are needed for drill presses, lathes and milling machines. Tool grinders are not heavy enough to handle larger sizes of cutters without excessive deflection.

Another user stated that the spindle bearings on a new

boring mill could not handle an overhung load without vibration at top speeds. In one plant, difficulty was encountered in the motor drive for a drill press set up for a tapping operation which called for frequent reversing from full speed.

MECHANICAL DRIVES

Two general complaints on mechanical components were lack of adequate maintenance data, and excessive cost in making replacements. Many special gears and bearings should be replaced by standard parts. Gear drives should have some kind of overload release to avoid stripping and replacement of the whole drive.

How can you tell when a part is worn enough to replace it? What parts should be stocked because they are special and would require a long time for replacement? What parts should be stocked because they are more likely to fail? One machine tool user states that today it is necessary to carry in stock as spares approximately 60 per cent of all the moving parts of his machine tools. And too many machines are not thoroughly checked out before shipment; it would be cheaper to fix them at the factory than send a man from the factory to fix them.

V-belts are subject to too much manufacturing variation between suppliers. When one belt of a multiple drive needs replacing, a complete set must be purchased. Standardization in nomenclature is needed; some suppliers specify belts by outside dimensions, some by inside dimension and others by mean length. V-belt pulleys also vary in depth and angle of grooves. One problem in the maintainence of V-belts is that they are difficult to inspect, adjust or remove without dismantling half of the machine.

Clutches are not protected well enough; oil gets into clutch surfaces. Some means should be provided to tell when adjustment is needed, so that corrections can be made to reduce slip before the facing is burned out. Magnetic brakes are not standardized as to mounting dimensions, and different makes are not interchangeable. Also, adjustments are required too frequently and disks must be replaced every year.

Where shaft speeds are synchronized by chain drives, the principal difficulty is chain lubrication.

A general complaint is that the labor cost of replacing a part is often greater than the cost of the part. One user reported that it was necessary to take down the machine to get at the motor in a recently designed lathe. Several men suggested a more general use of sub-assemblies that would reduce the labor required to get at a worn part.

LUBRICATION

Everyone wants automatic lubrication with one standard lubricant. Practically all people interviewed wanted force feed rather than splash systems, primarily to supply a metered amount of lubricant on an operating-time basis.

These lubricating systems should be incorporated in the basic design to delivery the exact amount required to each bearing. Labor is too expensive; specific needs for each bearing are too important to depend on operator judgment. Some reported that overlubrication is more of a problem than lack of lubrication. Some means of visual indication is desired to enable the operator to check on performance of the lubricating system. Indicators should be mounted in a group at eye level of the operator.

In discussing the large number of different lubricants often specified for a machine (nine in one case), it was recognized that the right oil for the right bearing was essential, but designs should be changed to avoid requiring special lubricants not readily obtainable. Some users want brand names specified; others want basic specifications, not brand names. One suggestion was the development of a "universal" heavy lubricant that could be thinned down to suit the different individual applications.

Lubrication of motors came in for considerable comment, particularly the lubricated-for-life types. Even the bearings in such motors require regular service, but there is no indication when they do need it. To simplify lubrication problems, one suggestion was that all machine tool motors be equipped with ball bearings and indicators to show the amount of grease in the bearing. Some fool-proof system of preventing over-greasing is needed to protect motor windings. Over-greasing sometimes blows out gaskets; some sort of a pressure release is wanted.

ELECTRIC MOTORS

Better accessibility for main drive motors was asked for by nearly every user—better accessibility for maintenance, trouble shooting, making electrical connections, and removing the motor for overhaul. Motors are too often buried deep in the machine or placed in out-of-the-way locations. The suggestion by one plant was that motors be taken out of the machine entirely; that functional values were too often subordinated to appearance.

A common request is that motor name plates be placed where they can be readily seen. Also, that electrical connections be made with flexible conduit so that motors can be removed by an electrician without the help of a mechanic. Longer leads are wanted, with the terminal box accessible on top of the motor.

Totally enclosed motors are frequently mentioned as an important need. Although the enclosure gives added protection to the motor windings, more frequent cleaning of the motor housing is essential to prevent motor overheating as the result of clogged cooling vents. Cleaning was mentioned as requiring more frequent maintenance than lubrication. To prevent overheating, suggestions encountered were water cooled frames, and external heat radiating ribs instead of fan cooling.

Motor mounting adjustments also came in for considerable discussion. They should be accessible and visible; the electrician should not have to work in the dark or by feel. Some asked for more general use of vibration mounts to eliminate effects of motor vibration; others experienced difficulty with mounts that deteriorated when soaked in oil.

ELECTRICAL CONTROLS

Control circuit components were commonly considered a major maintenance problem. Foreign matter and wear in contacts, and inaccessible locations, were specific objections. In many control panels, components are obtained from a half-dozen different suppliers, thus adding

to the problem of spare parts. Lack of service and maintenance data on the machine sometimes results in long down time while the trouble is being located and a replacement part obtained. Point-to-point voltage and resistance diagrams would help in checking.

While there has been some standardization of motor controls, the conviction is prevalent that much more is needed. For example, starters for the same power range should be interchangeable. Starter boxes should be smaller to minimize mounting problems. They should be tight to keep out dirt, chips, metallic dust, oil, and coolant, but still easy to open. Problems of coolant on contacts were mentioned frequently. (These criticisms appear to apply to older, non-JIC, machines).

Thermal overload relays were cited by several as a source of difficulty—they are not sufficiently sensitive; their operating tolerances are too wide. Three-phase relays are not always sufficiently balanced to prevent single-phasing and consequent motor burnout. More sensitive protective devices would prevent overheating and insulation damage to motors when operated at moderate overloads for a long time. One plant meets this problem by installing its own overload protection components.

Plug-in starters and relays were suggested by several men as one answer to the maintenance problem. This solution would mean that all suppliers' designs should be interchangeable. Another suggestion is to eliminate all loose parts and nuts, make mounting screws captive, and use pressure connectors on all wires.

For fractional-horsepower starters, a small toggle-action manual switch is needed with an under-voltage release and provision for locking in the off position.

Limit switches and solenoids received some pointed criticism. Too frequent coil burnout is a common comment on solenoids; short-lived return springs are a source of trouble also. One company finds it must regularly install its own limit switches on new machines. Another states that more than 20 per cent of service calls are to repair limit switches, about a third of the failures are mechanical rather than electrical.

Low-voltage control circuits are mentioned to be an important need by a number of plant men. Even a 115-volt system can be dangerous. To eliminate this hazard, voltages in the range of 6 to 24 volts are suggested; this is being done by many machine tool builders.

In selecting the transformer to reduce voltage, capacity should be great enough to provide machine lighting.

Plea for some method of indicating the load on a machine is widespread. In some cases, the desire was for protection from a too-eager operator. Several specifically mentioned an ammeter with a mark or red band on the dial which would be helpful in set-up, and also show when a worn tool was using too much power.

ELECTRONIC CIRCUITS

Increasing use of electronic control circuits is causing concern for most of the plant men interviewed. Inadequate tube life is the most common complaint. It seems to be general practice to make tube replacements at regular intervals, even though the tube is still operating satisfactorily.

Unnecessary refinements in design and consequent complexity is a common criticism of electronic speed and feed control devices, along with the difficulty of providing adequate maintenance. One user suggests interchangeable printed-circuit assemblies so complete control units can be replaced in the event of failure, and returned to the manufacturer for servicing. Some kind of a signal system is needed to show what unit is at fault.

Special long-life industrial electronic tubes are badly needed. Tubes fail too often from vibration. One company reported they had set up a special inspection system for new tubes, and often rejected 75 per cent in an effort to cut down failures on the line.

HYDRAULIC CONTROLS

By far the largest complaint on hydraulic equipment is the ever-present leakage. This causes serious housekeeping problems, increases the cost of operation and creates hazards. (Many users did not seem to know that good low-cost non-flammable fluids are available to reduce fire hazards.)

Several users mention problems arising from heat accumulating in the hydraulic system. One states that the temperature rise in a milling machine, as the result of accumulated heat in its hydraulic system after an hour or two of normal operation, produced enough differential expansion to throw the machine out of line. Others avoid this situation by running the machine at a slower than rated speed.

Some means of dissipating heat from the fluid is suggested by several users, such as larger tanks, fans or radiators. Also, temperature indicators are wanted to show when trouble is coming or in lieu of these an automatic control to shut down the machine when excessive heat is present. A better fluid for high temperature service is needed.

More accessibility for easier replacement of hydraulic components was wanted by just about every plant contacted. Several instances are cited in which machines had to be partially dismantled to get at some fitting, packing or pressure adjustment requiring frequent mantenance. Tubing should be located for replacement without tearing down the whole system; where tubes are bundled they should be color coded.

Another suggestion is to use manifolds and built-in pumps to minimize piping. Long rubber hose lines get in the way and introduce time delays when cleaning up around the machine.

Two other interesting comments concern speed of response and damping. Lag in system response and chattering are mentioned as arising from air entrapped in long lines of rubber hose. On pulsating loads, such as in broaching, some device is needed to dampen vibrations in the system. Also some types of pumps produce pressure surges which in time can break the lines.

Small leaks in pipe fittings that are buried in a maze of tubes are inaccessible to a wrench; disconnecting and reconnecting outer tubes to get at the leaky fitting may increase total leakage rather than reduce it. Fittings should be readily accessible and the number used be as small as possible.

As an example of poor accessibility, the hydraulic feed line inside the housing of a lathe of recent design has a gasket requiring frequent replacement. The access door

provided to reach the gasketed joints is too small for the mechanic's hands and the tools required for the job. So the machine must be taken down to replace a gasket costing a few cents.

Another example is a milling machine with a regulating valve tucked away inside the housing. To make simple adjustments requires unbolting a face plate and moving a gear assembly that is heavy enough to require an electric hoist. Eye-bolts were installed over the machine to make it more convenient to hang the hoist.

Too many special types of fittings are used in places where a standard compression, shoulder or flare fitting could just as well be used. One user wants a standard snap-on or readily detachable (but leak-proof) hydraulic fitting comparable to an electric plug-in connection.

Bleeder lines should be added at strategic points so main lines can be cleaned without giving the maintenance man and machine a bath of oil.

But the largest single maintenance item on hydraulic equipment is leaky packings. While there has been some improvement in packing materials, much more is still needed. Two users suggest elimination of packing entirely, changing over to seals. When one packing in a cylinder needs replacement, it should not be necessary to replace all.

Getting back to leakage, a number of specific comments were made. Piping should be better supported to prevent leaks caused by vibration; tubing should be bent rather than use elbows and fittings to change the direction of the line. Why not use flexible (plastics) tubing–at least up to permitted pressures?

Adjustments in hydraulic pressure control and regulating valves are too difficult to make, take too long, and are too critical. Valves should be designed so these adjustments would be easier to make. Tolerances are so close on valve parts that they must be individually stocked. There should be at least one standard interchangeable spool-type valve.

Automatic feed control valves are becoming too complex; one valve often does too many operations and is too difficult to service. Commercially available components should be used so that repairs can be made in the plant instead of sending the part back to the manufacturer.

FILTERING OF HYDRAULIC FLUIDS

Interest in filtering is very general; in fact, keeping hydraulic oil clean came up in one way or another in nearly every interview. Oil filters supplied on machines today are said to be erratic in operation and lacking in capacity. An additional outside line filter with a pump should be included to improve filtering effectiveness and save frequent cleaning of inside lines.

Clarification of oil on some regular schedule is mentioned by several as necessary, even though filters are built into the machine. Centrifugal clarifiers are suggested as being more effective than the usual strainer types. Filtering methods should remove contaminating fluids as well as dirt; some coolant gets past even the best seals.

HYDRAULIC PUMPS AND MOTORS

One fairly common topic of concern is the power ratings of hydraulic motors. They occupy too much space per horsepower rating; they are not standardized as to mounting dimensions; ratings are misleading when they do not take discharge rate and back pressure into account.

Pumps are too noisy; smoother flow is needed; over-pressure protection is lacking. All pumps should be designed to operate on one standard fluid.

OPERATOR COMFORT AND SAFETY

Increasing interest in the human aspects of machine operation is prominent in the interviews. More operator comfort and safety, greater convenience of controls, fewer human decisions–all are regularly mentioned.

Many machines are delivered without adequate guards around work areas. Sometimes the designer of the machine fails to provide enough finger clearance around dials, control levers, and hand wheels.

Shape of control handles, knobs and levers should be standardized as to function so an operator can tell without looking what control he is using. Learning time can be decreased, and it will help in shifting an operator to another machine if shapes and functions are standardized on all machines.

Relative position of controls should also be standardized by function. Pendant controls should be more generally used to bring the control within easy reach of the operator.

"Design machines so the operator can sit down," is another specific suggestion. If the operator must stand up, the height of the controls should be adjustable. Bring all controls within easy reach; design in fail-safe functions so the machine will protect itself; incorporate safety power-disconnect devices on doors of change gear compartments.

Put pressure gages where the operator can note any deviation from normal. Use counter dials to eliminate errors in reading scales. Automatic loading and unloading should be more generally used.

Some examples are cited of machines needing redesign for operator convenience. In one instance, control levers cannot be reached by the operator when he is in position to watch the cutting tool. On another, the start-stop button is on the left end of the bed where it cannot be reached from the front of the machine.

Machines should be easier to clean, with more attention given to elimination of pockets. Chips should be easier to remove. Many coolant pans are so wide that operators cannot get near the work.

Interest is expressed in built-in lighting. One plant, insists on installing its own machine lighting, indicating little confidence in the ability of the machine designer to provide the proper amount of lumination under varying conditions of machine operation. But most others enter a plea for adequate designed-in light for the work and for dials that must be read.

One suggestion is to use white lights on the work, green lights in indicators to show when equipment is ready to operate, and red lights to signal that something is locked.

EDITOR'S NOTE—These comments were received with the promise that the source would not be identified. We regret therefore that no further information on any specific comment is available.

It was a rewarding experience to the editors; we hope it will prove helpful to readers. And we take this opportunity to thank all those who contributed and for the fine spirit in which the contributions were made.

Designing the Product to Suit . . .

Human Dimensions

Dimensional data from many independent sources as it applies to reach, vision, space enclosure, seating and standing; then case histories, and complete list of sources for data.

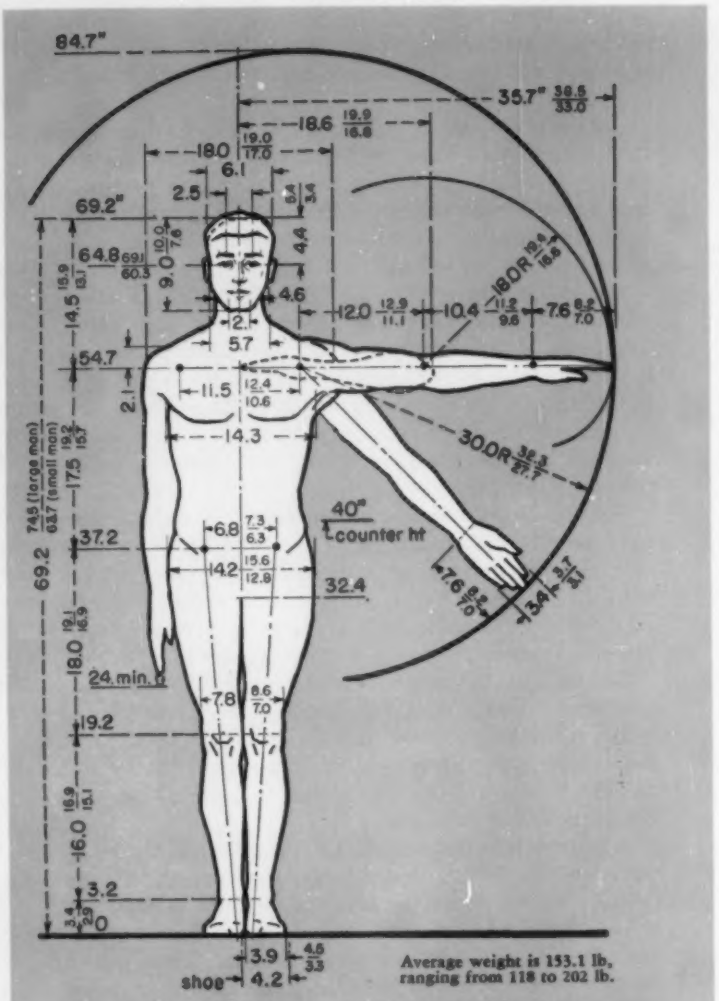


Fig. 1—Human dimensions of the average adult male based on the 2½ to 97½ per cent range of measured sub-

ROBERT H. HOSE
Partner, Henry Dreyfuss

INDUSTRIAL DESIGNERS are always conscious of the ultimate user of the product. The Henry Dreyfuss doctrine is based on the principle that, "the object being worked on is going to be ridden in, sat upon, looked at, talked into, activated, operated, or in some other way used by people individually or en masse. When the point of contact between product and the people becomes a point of friction, then the industrial designer has failed. If, on the other hand, people are made safer, more comfortable, more eager to purchase, more efficient, or just plain happier, by contact with the product, then the designer has succeeded."

Human dimensions are obtained by averaging research data developed by many independent sources. The body dimensions shown in Fig. 1 have become the basic guide and were developed to embrace the 2½ to 97½ percentile range of dimensions; (the upper and lower 2½ per cent of extremes were excluded.) These data, it must be emphasized, can be used for general guidance only.

The designer must interpret and adapt the data to each specific problem with which he is involved. For example, it would be unwise to accept a given chair height dimension as the basis for positioning a shelf in front of a seated operator, without full consideration of the construction of the chair cushion and its relative compression. Allowances must also be made for the tendency of the human body to sag or assume a more relaxed position as a result of fatigue or strain.

Application of this type of anthropometric information during the design stage of a product involves little in the way of cost but much thought and interpretation. Considerations involved in most products are reach, vision, space enclosure and seating and standing requirements.

REACH

Hand or foot controls must be placed so that the operator will not be inconvenienced or fatigued in operating them. Normal limitations of reach of both the arm

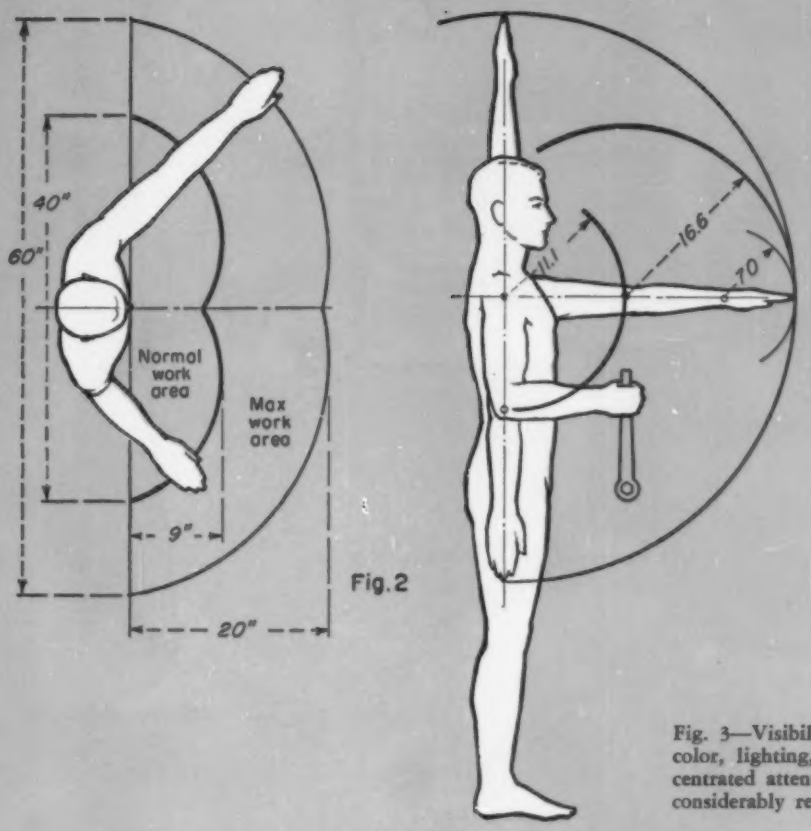


Fig. 2

Fig. 2—Reach of standing or seated operators may be extended beyond these limits by lateral motion or pivoting at the waist. Drawings are based on the small man (2½ percentile), body rigid and stationary.

Fig. 3

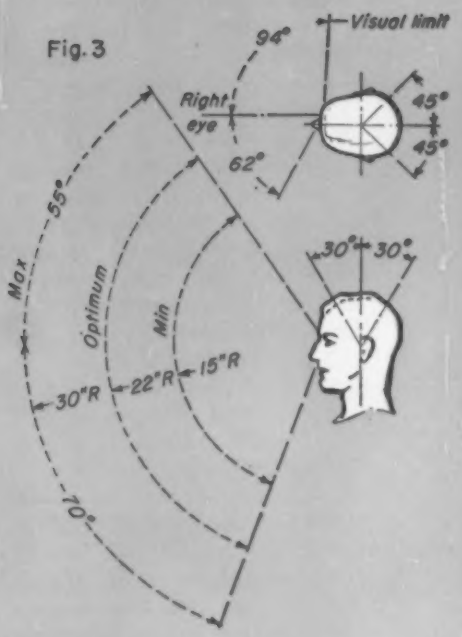


Fig. 3—Visibility studies must include considerations of size, color, lighting, and purpose of the equipment. Where concentrated attention will be required, effective visual areas are considerably reduced.

and leg extremities must be acknowledged, as shown in Fig. 2, and consideration given to the duration, frequency, and sequence of the reach motions in order to minimize operational fatigue.

When products are operated from a seated position, vision, arm reach, leg clearance under counters or shelves, and body support by means of chair structure, elbow rests, and similar elements are important factors. In the design of a bicycle, for example, it is important to position the seat so that the body is in a comfortable position while pedaling, and the body weight is properly distributed on the frame of the bicycle so that pedaling does not restrict circulation in the leg or the operator's ability to apply the maximum force to the pedal with the minimum muscular fatigue.

When complicated, tedious, and fatiguing operations are required for long periods of time, it has been found desirable to have a seat which can tilt the body slightly forward so as to increase the operator's arm reach. Other control operations are relatively casual and infrequent and may best be accomplished if the operator is comfortably seated in an upholstered chair.

Control areas may be arranged in an arc around the operator to coincide as nearly as possible with his normal reach limitations. This principle has been applied to such items as control consoles, telephone switchboards, broadcast control equipment and aircraft cockpit design. Considerations of arm reach must be modified to acknowledge the fact that the entire body will pivot at the waist to extend reach, or might bend at the knees to a lower position, and that there are certain areas best suited for controls requiring strong muscular action.

It is apparent that anthropometric dimensional requirements may differ substantially dependent upon the amount and type of use of the product. Specific equipments must be designed to acknowledge the particular characteristics of the operator's posture involved.

VISION

Products which must be handled, manipulated, controlled, or observed require specific design to promote visibility. Some equipment will be scanned from either nearby or remote points. Others require concentrated attention to derive detailed information. Proper positioning of those components requiring observation, such as

instruments and work areas, necessitates the analysis of normal body sag and head tilt which are inherent in the fatigue cycle, the effect of direct or indirect lighting on perception, reflection and glare from highly polished surfaces, and the size of designations or objects to be observed and their distance from the eye.

Visual control areas are generally located as shown in Fig. 3. Frequently, where accurate observations and interpretation are required, figures and dials are enlarged to be more than normally legible so as to accommodate the requirements of those who have sub-normal vision. Color contrast may also be an important aid in accenting or minimizing visual elements. Color discrimination is most effective over a relatively small area directly in front of the operator's eyes.

Visual requirements for seated operators are similar to those of the standing operator. He will be subject to a certain amount of body sag if the operation is of long duration or fatiguing and he will be capable of normal body movement. Any suggested distance from eye to object must be used as a guide only and properly modified to fulfill the specific requirements of the operational problem.

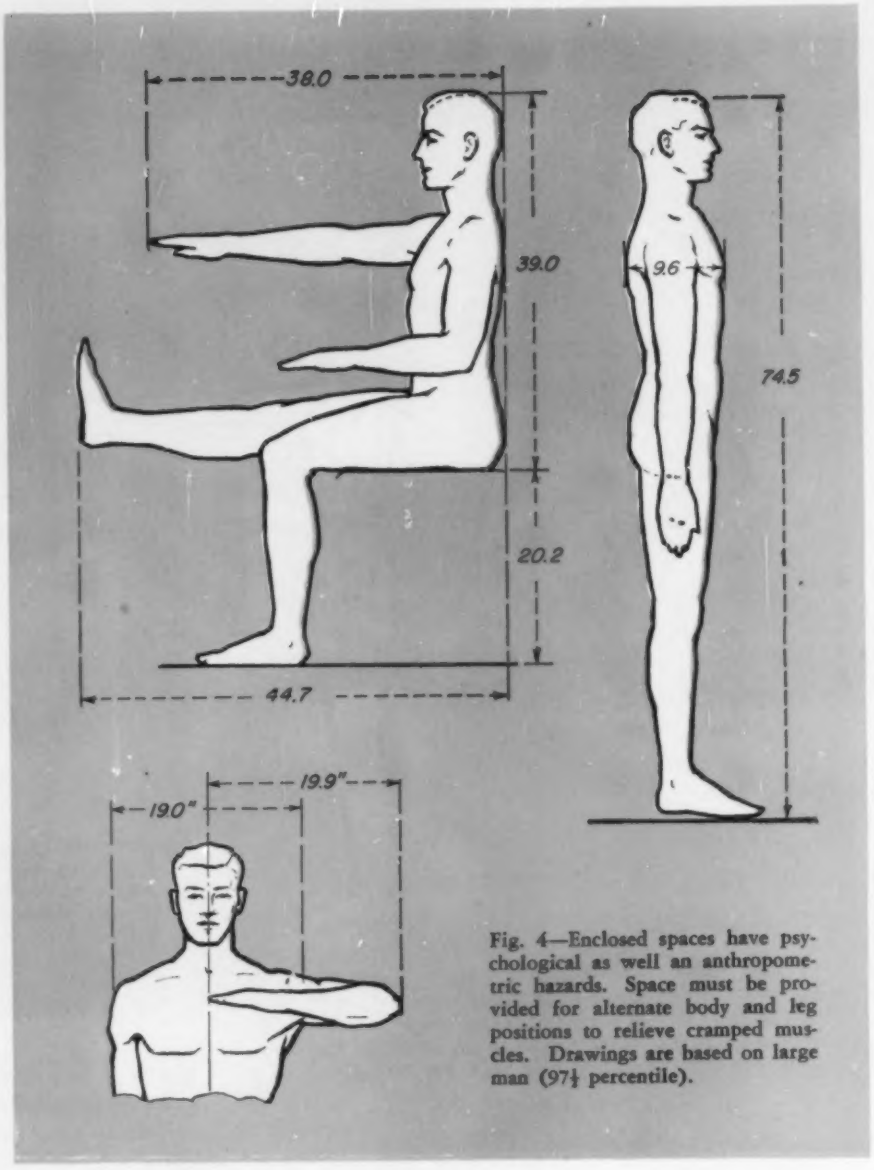


Fig. 4—Enclosed spaces have psychological as well an anthropometric hazards. Space must be provided for alternate body and leg positions to relieve cramped muscles. Drawings are based on large man (97½ percentile).

ENCLOSED SPACE

When the human body is confined within a restricted space a different set of dimensional data, as shown in Fig. 4, must be used in establishing clearances and desirable spatial requirements.

The human body fatigues rapidly within confined spaces, partially because of the psychological effect of confinement. The physical need to stretch and relax body muscles requires that confined areas allow some amount of this type of motion. Enclosed volumes must be designed for use by the large man who is at the upper 97½ percentile position. The average or small man will then be comfortably accommodated.

In confined areas such as in aircraft cockpits, locomotive cabs, and even automobiles, the planes and surfaces surrounding the user may be irregular and present hazardous edges and corners. Care must be taken to remove those hazards from the operator's normal envelope of motion so as to reduce the possibility of injury.

Additional precautions are required if the man is confined in an enclosure which is in motion and tends to throw him about. It has been observed that often the greater the distance an operator's body is thrown, the more serious the resulting impact injury. Padded surfaces, close by, are safer than unpadded surfaces at a distance.

Frequently, the illumination of a confined operating area is limited and this may create visual problems requiring certain dimensional adjustments to promote better vision and optical definition.

SEATING

Basic dimensions for seated operators are shown in Fig. 5. The type of seat and its position relative to the work or use areas must be such that it will give the maximum operator comfort, reach, vision and convenience.

The human body is so constructed that certain comfort angles must be maintained in order to avoid restriction of circulation and unnecessary fatigue. This is particularly true with respect to leg position and it is desirable to allow sufficient clearance in "knee hole" areas so that the legs can be relaxed from time to time.

Lateral clearances should allow the operator to occasionally stretch and relax. Shelf structures must be posi-

Fig. 5—Seating is dependent on reach, vision, and work load on the operator. This drawing is based on the small man which accommodates the reach limitations of 95 per cent of all men.

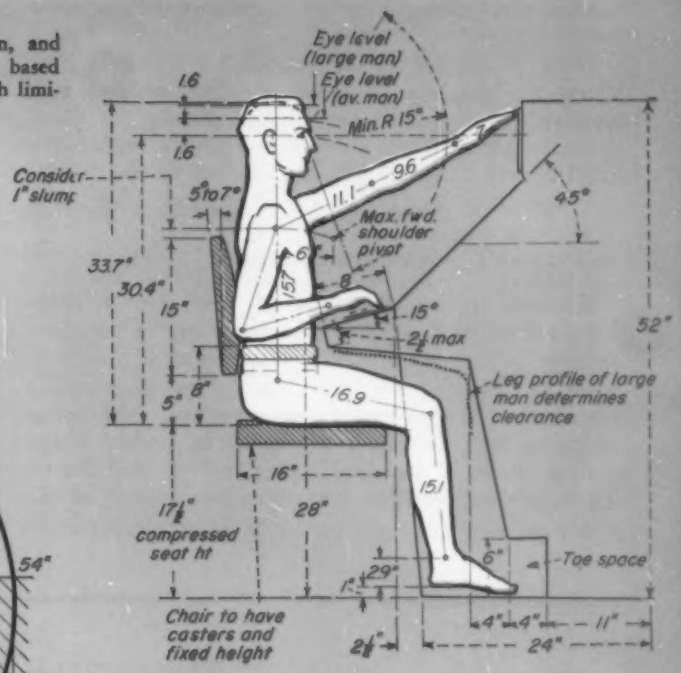
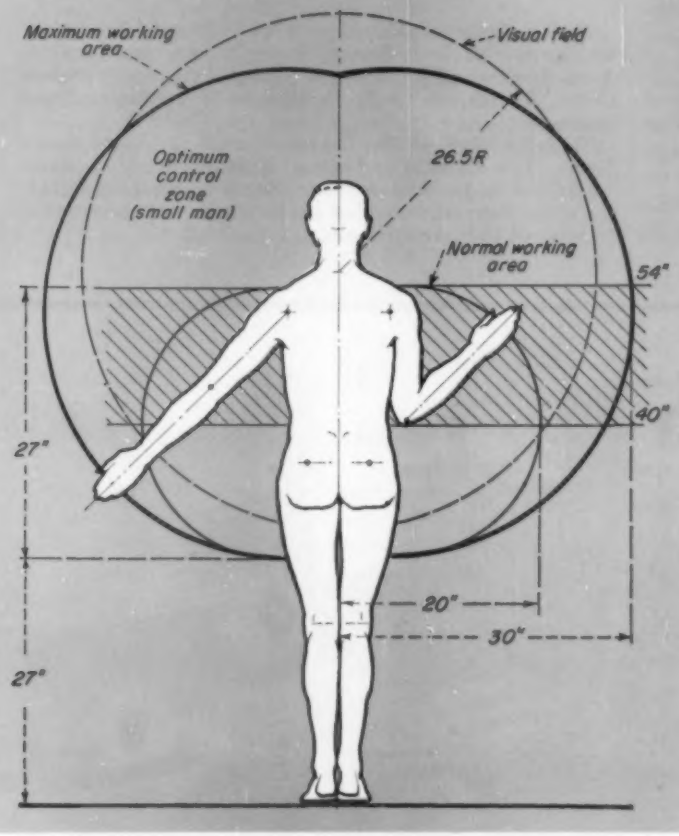


Fig. 6—Standing operator with most effective areas for controls cross hatched. Drawing is based on small man (2½ percentile).



tioned with respect to seat height and arm rests so as to provide a comfortable supporting surface which does not present a bumping edge to the forearm or elbow. Large equipment should be so arranged that it will be easy to get into and out of the operator's chair without danger of impact injury.

Objects that must be manipulated or observed from a seated position are generally placed at a distance which is a compromise of optimum visual, reach, and other requirements. If the observation of visual controls is of primary importance, the product may be designed to favor those dimensions related to visual perception. Equipments requiring considerable manual manipulation, such as telephone switchboards, test control consoles, etc., may, of necessity, be based on reach as well as vision requirements and, therefore, have to be adjusted in size, proportion, and value contrast, to properly satisfy both demands.

The user will almost instinctively lean forward from an erect position and will slouch in the chair after a few minutes at work. Important manual-visual controls should be placed to acknowledge these tendencies.

Where leg or foot action is required as when activating a brake pedal or the foot pedal of a piano, muscular coordination and force requirements should determine the angular position of the leg. Clearance must be provided around the legs to enable the operator to make the necessary motions.

STANDING

Visual requirements are almost identical for standing or seated operators. However, a standing operator is able to reach further than a seated operator because of his ability to bend forward or laterally from the waist and to bend his knees to reach a low object. In addition, it is natural for an individual to move laterally when standing. This enables the designer to place objects to be observed or manipulated over a greater lateral area. It is convenient for the operator to bend forward from the hips provided there is no particular force required in the control operation which would tend to cause the operator to suffer muscular fatigue or back strain.

When control areas are designed for stand-up operation it is generally good practice to position them for use by average or small men. The tall man can obviously bend to reach or see an object but the short individual cannot increase his height.

It is often desirable to position controls so that the operator can see over the top of the control structure to other locations in a room. This may require that manual or visual control planes be sloped in order to obtain the

required area below the operator's eye level within proper reach-vision distances.

Many products must be designed for operation from either the standing or seated position, perhaps with emphasis on the seated position but allowing for observational control from a standing position behind the operator's chair. Again, these requirements call for suitable modification in the application of anthropometric data.

Sources of Data

Research and analytical work has been done by many independent civilian scientific groups and government agencies to determine reliable anthropometric standards. Many of these studies were made under specialized conditions and with specific analytical objectives. The figures which we have developed for our use in product design are the results of weighted averages of all available research information. The dimensions incorporated on the charts and diagrams reproduced with this article are based on normal or average requirements and are considered to be guidance dimensions only. Each dimension must be reviewed and analyzed with reference to its application to a given design problem.

Attached is a partial list of sources which we have used as guidance in developing our standards. Our dimensions confirm many of those included in these reference sources but may vary slightly due to the averaging procedure.

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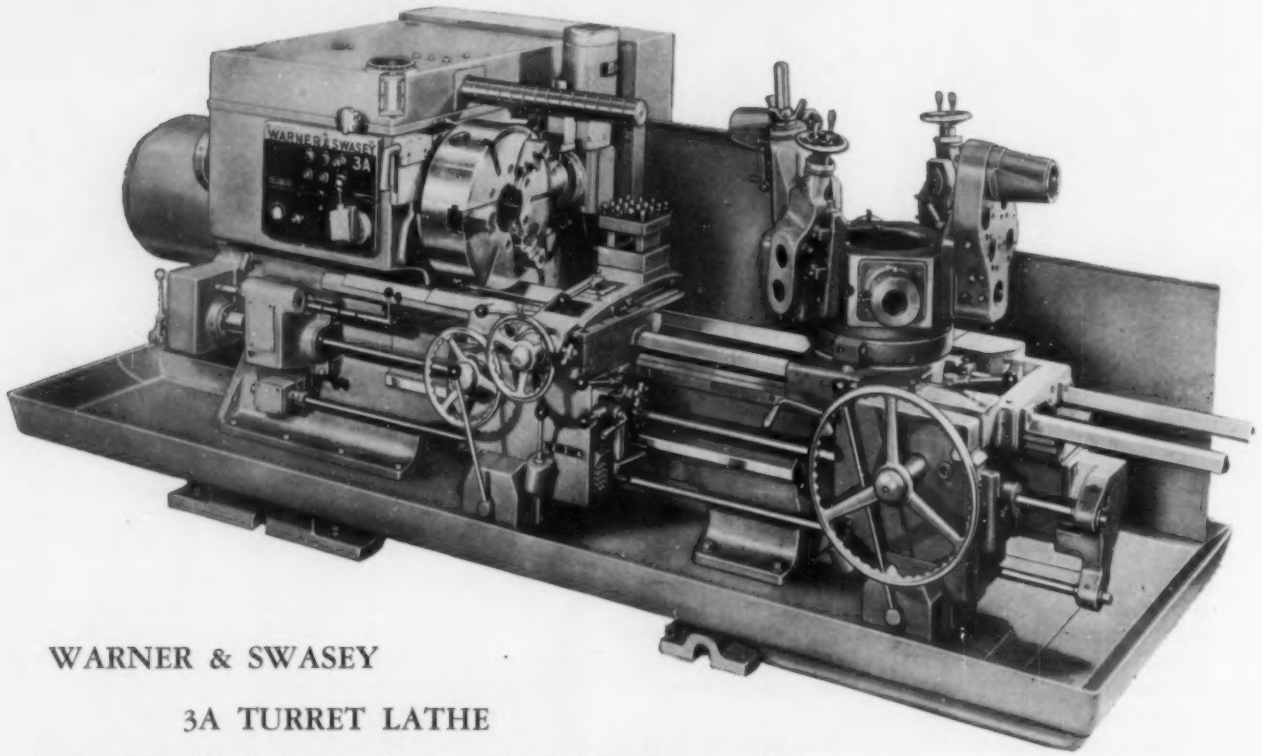
"The Geometry of the Human Figure," by Ernest Irving Freese. First appeared in *American Architect*, July 1934. Later reproduced in *American Architect Time-Saver Standards*, February 1936. Bone structure pivot points provide basic information for over-all body measurements.



WARNER & SWASEY

3A TURRET LATHE

A turret lathe falls in the general category of heavy industrial equipment which requires stand-up operation and the use of moderate to heavy control forces. Several visual areas are involved and fatigue factors are apt to be high. Machine requirements often complicate the operator's control motions and vision and he is generally subjected to high noise level and inadequate illumination.

A turret lathe operator performs most of his functions from a position directly in front of the stock in the chuck. He frequently leans over to examine the material or adjust the cutting tools. The height of the chuck above the floor is perhaps the most critical anthropometric dimension involved in turret lathe design.

Because of the size and relative complexity of the manual control operations of a lathe, the operator must periodically step from side to side in order to reach various controls. Within the limits of the mechanical restrictions, all control devices are placed at the most practical elevation above the floor, so as to make it easy for the operator to use them. Some wheel type controls vary in diameter to compensate for their mechanically determined elevation and the forces required to move them.

"Report on Anthropometric Measurements," project 9, Armed Force Medical Research Lab., Ft. Knox, Ky., February 1, 1943. Nearly 3000 men were measured to obtain average dimensions. Results of this study were very similar to corresponding studies carried out by the Air Corps and Harvard Medical School.

"Handbook of Human Engineering Data," Tech. Report No. SDC 199-1-1, Part II, Tufts College. 2,958 cadets and 1,959 civilians were measured to verify average body dimensions including head dimensions and body weight.

"Human Engineering Guide for Equipment Designers," by Wesley E. Woodson, University of California Press, 1954. Visual limitations, limitations of color discrimination, maximum and comfortable limb angles, and seating data.

"A Survey in Seating," by E. A. Hooten, Dept. of Anthropology Statistical Lab., Harvard University, 1945. Heywood-Wakefield Co., Gardner, Mass. 1,959 males and 1,908 females were measured for information on seating requirements.

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"Riding Comfort," SAE Transactions, Vol. 47, No. 5; for the Murray Corp., by University of Michigan. Body center of gravity and pivot points analyzed with respect to good seating requirements.

"Human Limbs and Their Substitutes," McGraw-Hill, 1954. Prepared under the sponsorship of: Advisory Committee on Artificial Limbs, National Academy of Sciences, National Research Council. Gives location of the mechanical axis of the leg and data on leg movement and joint characteristics.

EDITOR'S NOTE—For a further discussion of human engineering and design the reader is referred to "Designing for People," by Henry Dreyfuss, Simon and Schuster, 1955.

Lever controls of the push or pull type are extended so as to be as near as possible to the desirable hand operating position.

Electrical and mechanical set-up and operational controls are grouped on the front of the main head casting in a position which can be readily reached by the operator from his normal position in front of the chuck. Some important visual controls are built at an angle so as to facilitate observation when standing to the right of the main control panel.

HYSTER LIFT TRUCK

A lift truck is a heavy industrial tool which must be controlled from a seated position while the truck is in motion. Both short and long-range visual control are required. Both arms and legs are used in the control operation. The operator must climb into and get out of the control seat. He may be subjected to abrupt stops which tend to throw his body forward, backward, or to the side. The steering wheel may be the primary manual control but he must be able to conveniently reach the "dash" controls, brake levers, etc.

He must be able to see not only the controls mounted on the truck, but the object being lifted and the place where it will be deposited. The operator can bend his body to facilitate reach and vision. The seating area is large and comfortably padded.

In order to provide direct vision from the eye to the floor in front of

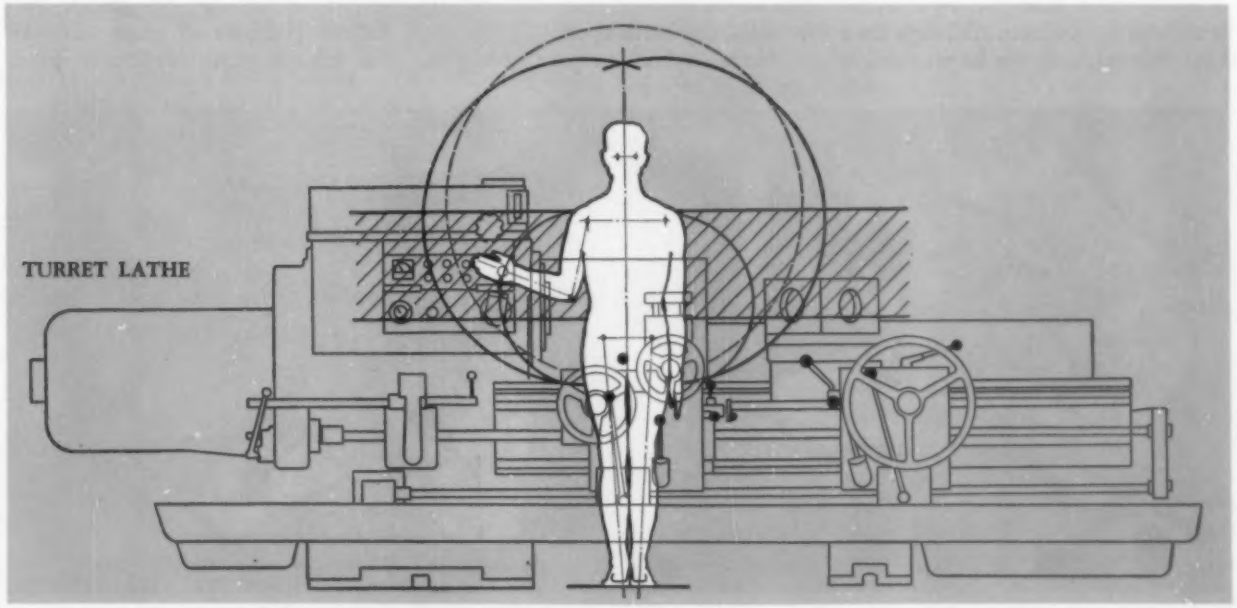


Fig. 7—Controls are grouped near the normal operating area. Major control panel is within easy reach of operator's left hand.

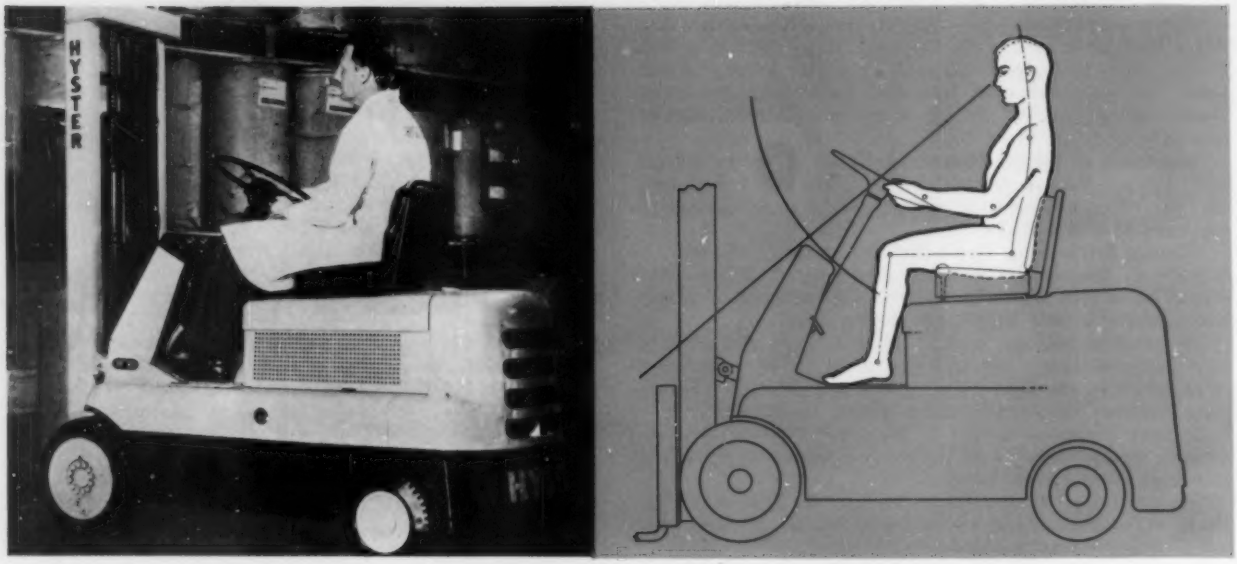


Fig. 8—Lift truck dashboard has been lowered and angled to increase visibility of load and forks.

the truck, the "dash" control area has been lowered and angled. The plane of these controls has been tilted and rotated in an arc which is centered on a theoretical point established as a compromise between the center of the eye and the center of the shoulder pivot.

M-46 TANK DRIVER'S COMPARTMENT

A tank operator is confined within a minimum enclosed volume, is under extreme nervous tension, is subjected to strenuous body fatigue, and frequently is unable to obtain assistance or relief in his control operation. Because of the structure required by ballistic considerations, he is confined in an irregularly shaped enclosure and must be seated in a relatively awkward and fatiguing position. Although some protective padding can be provided to minimize impact injury, there are, potential hazards in the many hard planes, edges and corners of control units suspended before him in space.

Access and egress from the driver's compartment are awkward because minimum hatch openings are desirable and their locations on the hull are to a large degree predicated on safety and vision requirements when driving with the top hatch open.

Reach operations are complex. Considerable force is required to open and close the top entrance hatch. The steering mechanisms, brake lever and other electro-mechanical controls have been placed as conveniently as possible within the mechanical and space limitations of the structure.

Vision to the terrain ahead of the tank is provided by an optical periscope when the top hatch is closed. When not in combat he may be driving with the top hatch open and so an adjustable seat is required to place his head either through the hatch or below it with his eye in front of the periscope. The control operation is therefore complicated since the operator must be able to assume two distinct positions in space while all the interior controls remain fixed.

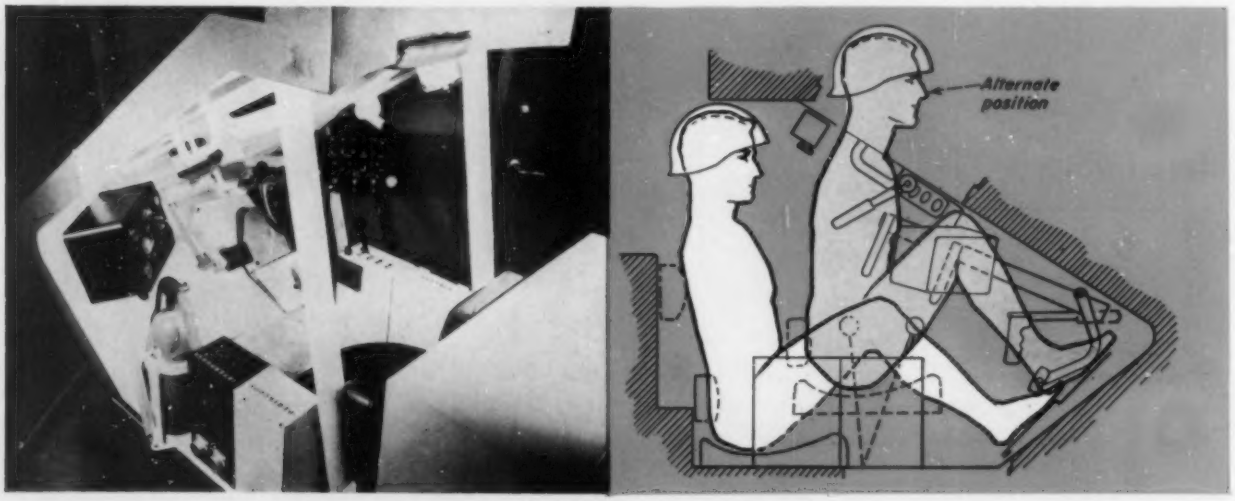


Fig. 9—Tank driver's compartment requires two seating positions with accessibility of controls in either position.

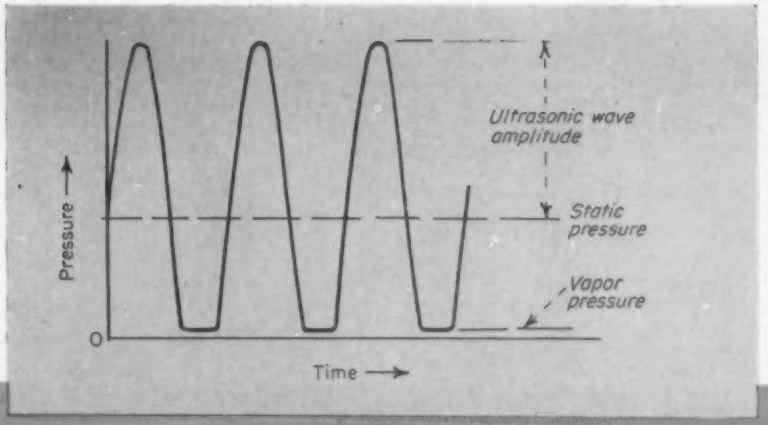


Fig. 1—Instantaneous pressure at a point in the fluid as a function of time. Cavitation occurs when the pressure drops below the vapor pressure of the fluid.

Cavitation Attack In Ultrasonic Equipment

Phenomena of cavitation and characteristics of ceramic transducers; test method devised to study cavitation damage; methods for protecting transducer electrodes; resistance of various materials and coatings to cavitation attack.

DR. L. A. PETERMANN, GULTON INDUSTRIES

CAVITATION DAMAGE is well known in turbines and pumps. At first the surfaces are pitted only slightly, but the damage rate soon accelerates into deep attack, leaving surfaces with a very rough finish. The efficiency of the pump or turbine is badly impaired because of friction losses and leakage.

Ultrasonic cavitation damage appears to be similar but begins sooner and progresses faster. Where it takes several months of continuous operation in a turbine to show a given amount of damage, it may take only a few hours with ultrasonic cavitation. Some explanation of this accelerated damage is found in the repetition rate of the shocks. In a turbine, repetition rate may not exceed a few hundred or a few thousand shocks per second; in ultrasonic equipment repetition rates are several hundred thousand per second.

Cavitation Phenomena

Characteristic noise which is especially loud at low frequencies and high intensities (amplitudes) of ultrasonic waves.

Bubbles of various sizes especially at low frequencies. Since they may be very small, it is sometimes necessary to use optical magnification or to observe the diffusion of light by these bubbles.

Fluorescence of the liquid when cavitation is very intense.

Chemical effects, such as liberation of free chlorine when cavitation takes place in a mixture of water and carbon tetrachloride.

Abrasion and cavitation damage to submerged bodies and to the container.

When each of the cavitation bubbles collapses, a shock wave is generated in which the peak pressure can attain values as high as 10,000 to 100,000 atmospheres. The high repetition rate of shock waves, especially in ultrasonic cavitation, is held responsible for observed cavitation damage. If an abrasive is added to the liquid in which cavitation takes place, materials wear so quickly that, based on this principle, ultrasonic drills have found many industrial applications in the machining of hard materials.

A sonic or ultrasonic wave propagated in a liquid, if of sufficient amplitude, can produce cavitation. As each point in the fluid is traversed by the ultrasonic wave, the pressure is instantaneously equal to the algebraic sum

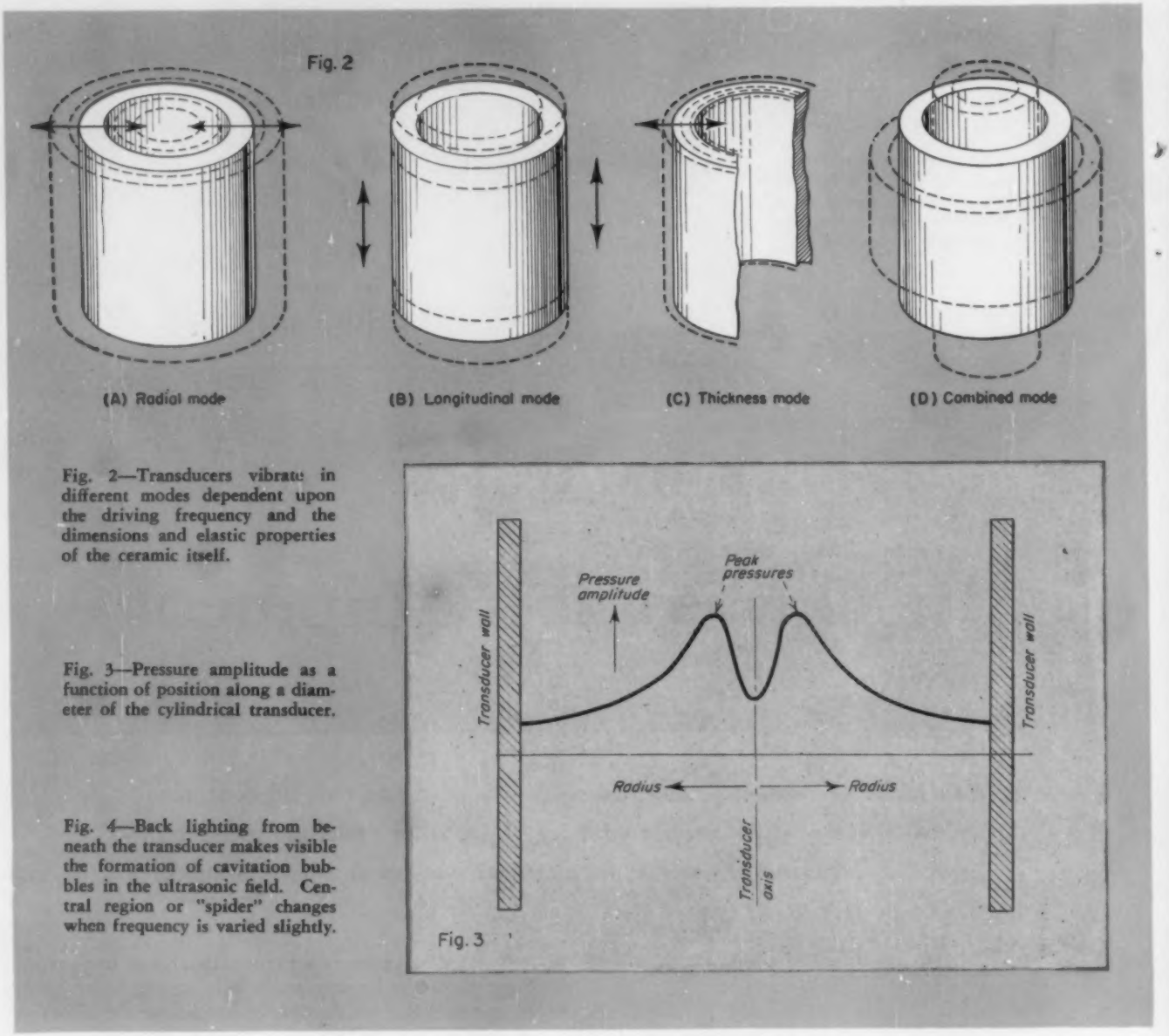


Fig. 2—Transducers vibrate in different modes dependent upon the driving frequency and the dimensions and elastic properties of the ceramic itself.

Fig. 3—Pressure amplitude as a function of position along a diameter of the cylindrical transducer.

Fig. 4—Back lighting from beneath the transducer makes visible the formation of cavitation bubbles in the ultrasonic field. Central region or "spider" changes when frequency is varied slightly.

of the amplitude of the wave and the static pressure of the fluid. When the wave amplitude is larger than the static pressure, there are intervals of time during which the pressure is nearly zero in the liquid and, as shown in Fig. 1, "pseudo cavitation" may occur.

The reduction in pressure required to produce cavitation bubbles depends very largely on the purity of the liquid. If a liquid contains dissolved gases, microscopic gas bubbles, or dust particles, cavitation bubbles form easily and a reduction in pressure to the vapor pressure of the fluid is sufficient to produce "pseudo cavitation." If the liquid under consideration is completely degassed and very clean, entire areas of the fluid seem to strain equally, distributing the stress of the reduced pressure and localized bubbles do not appear. "Negative stresses," caused by the excess of ultrasonic pressure amplitude over the static pressure, as high as 200 or 300 atmospheres may be required to produce bubbles, and this condition is known as "true cavitation."

ULTRASONIC TRANSDUCERS

Barium titanate ceramic transducers, which are polarized ferroelectrics, function like piezoelectric transducers in that when an electric field is applied across the polarized ceramic, there results a change in the dimensions of the transducer roughly proportional to the strength of the electric field. If the applied field is an a-c field, the dimensions of the transducer will change periodically. The dimensions and elastic properties of the ceramic determine the natural frequencies at which the transducer will vibrate in its different modes. As the frequency of the applied a-c field approaches the natural frequencies of the different modes, the amplitude of dimensional change greatly increases.

The most important modes of vibration are shown in Fig. 2: radial as shown at (A); longitudinal as shown at (B); and thickness as shown at (C). The various modes of vibration are always coupled; motion in the longitudinal

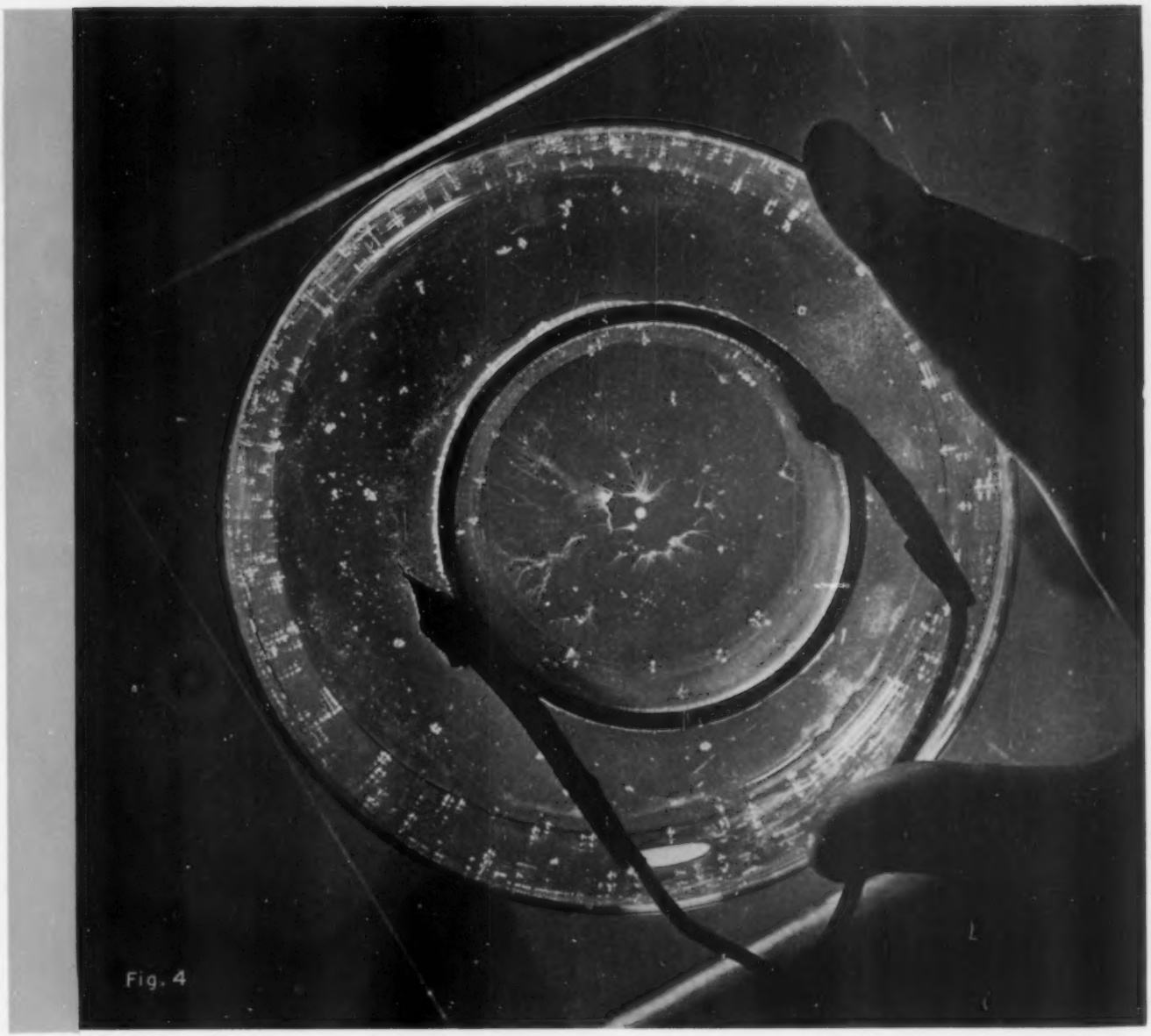


Fig. 4

direction is always accompanied by a motion in the radial direction as shown at (D). Therefore, a cylinder can be driven at the relatively low longitudinal mechanical resonance frequency and there will be considerable motion in the radial direction.

As the transducer vibrates in its radial mode a pressure wave is set up in the ring of fluid bordering the transducer. This high pressure ring moves toward the central axis increasing in amplitude as the radius and circumference reduce. Theoretically, an infinite pressure would be reached at the center if cavitation did not occur. However, cavitation bubbles form and absorb or reflect the ultrasonic wave back to the walls of the transducer. The variation of pressure across the cylinder is shown in Fig. 3. Peak values of pressure amplitude may reach very high values, frequently several hundred times the pressure amplitude at the cylinder wall. Cavitation bubbles collect in star-shaped or spider-shaped forms. These regions of intense cavitation (seen by the light they diffuse in Fig. 4) undergo complicated changes of shape when the frequency is slightly varied near the resonance of the transducer.

TESTING FOR CAVITATION DAMAGE

The life of an ultrasonic transducer is usually very short if there is no special protection against cavitation damage. The following test procedure was used to devise suitable protection for the transducers as well as to determine the effect of cavitation on various materials.

As shown in Fig. 5, a 16-gal pyrex cylindrical container was used as a trough. The cooling system consisted of a copper tubing coil immersed in the trough with cold tap water as the coolant, permitting control of the equilibrium temperature during the test. The transducers were Glennite piezoelectric ceramic No. 103, all having a cylindrical shape of between 1½ and 6 in.

Fig. 5—Setup for testing cavitation damage to ceramic transducer coatings and rods of different materials.

Fig. 6—Cavitation damage on the electrodes of a Glennite piezoelectric transducer driven for 250 hr. Outer electrode was unprotected; inner electrode protected with a glaze was not visibly affected.

Fig. 7—After 1100 hr of ultrasonic vibration at 44 kc in tap water, this glazed Glennite piezoelectric transducer is still in relatively good condition.

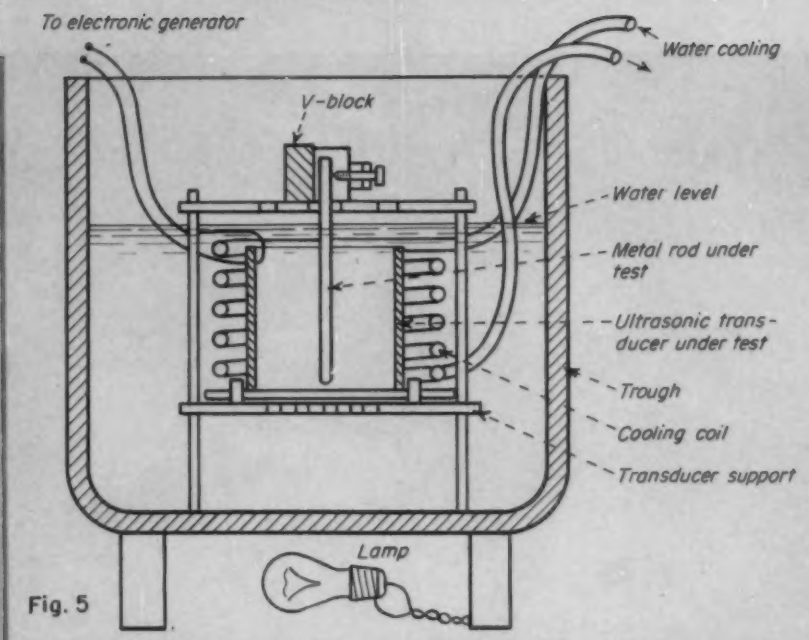


Fig. 5

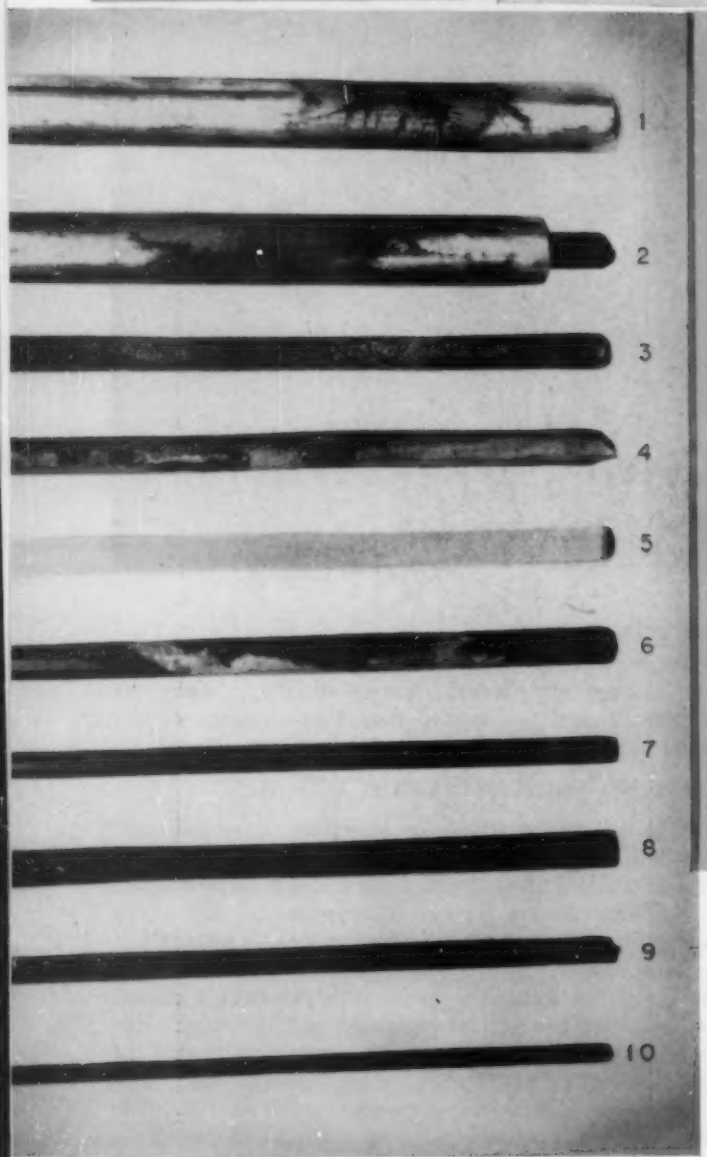


Fig. 8—Relative cavitation damage to various materials tested in tap water in focal region of cylindrical transducers.

1. Aluminum rod ¼ in. dia; 71 hr at 44 kc. Fine pitting all around the section of the rod corresponding to the middle of the ultrasonic field followed fairly regular patterns, and the legs of the cavitation "spider" are easily recognized. Under the microscope, the holes are fairly regular in shape, with smooth bottoms, sharp edges and deep undercuts.

2. Similar aluminum rod; same treatment for 174 hr. Damage is deeper with many more isolated holes in the metal. In some regions the surface has an even mat finish. Chemical reaction produced black compounds in small quantities on the surface of the aluminum in regions of heaviest mechanical attack. A thick coat of hard mineral, silicia or aluminum oxide formed at the liquid level. On long tests regions of lower cavitation intensity have a uniform mat finish on which the deep marks of the spider legs are superimposed.

3. Aluminum rod ¼ in. dia; immersed 3 in. for 271 hr at 33 kc. Cavitation intensity was much higher than in the two preceding samples because of the smaller diameter of the rod. Attack is so deep that there is nc longer any regular pattern of holes corresponding to the cavitation spider. The initial metal surface has been completely removed from the rod on nearly the entire width of the ultrasonic beam. Of the 3 in. immersed almost 2½ in. has been deeply undercut. Chemical attack is not

OD, and 1 to 6 in. long. They were firmly positioned on a rack immersed in the trough and connected to an electronic generator capable of delivering up to 400 watts at any frequency between 10 kc and 1.2 mc. On the same rack, a V-block was attached to hold the test rods in the cavitation field on the axis of the cylinder. A small lamp sent light through the trough and through holes in the rack making it possible to observe the cavi-

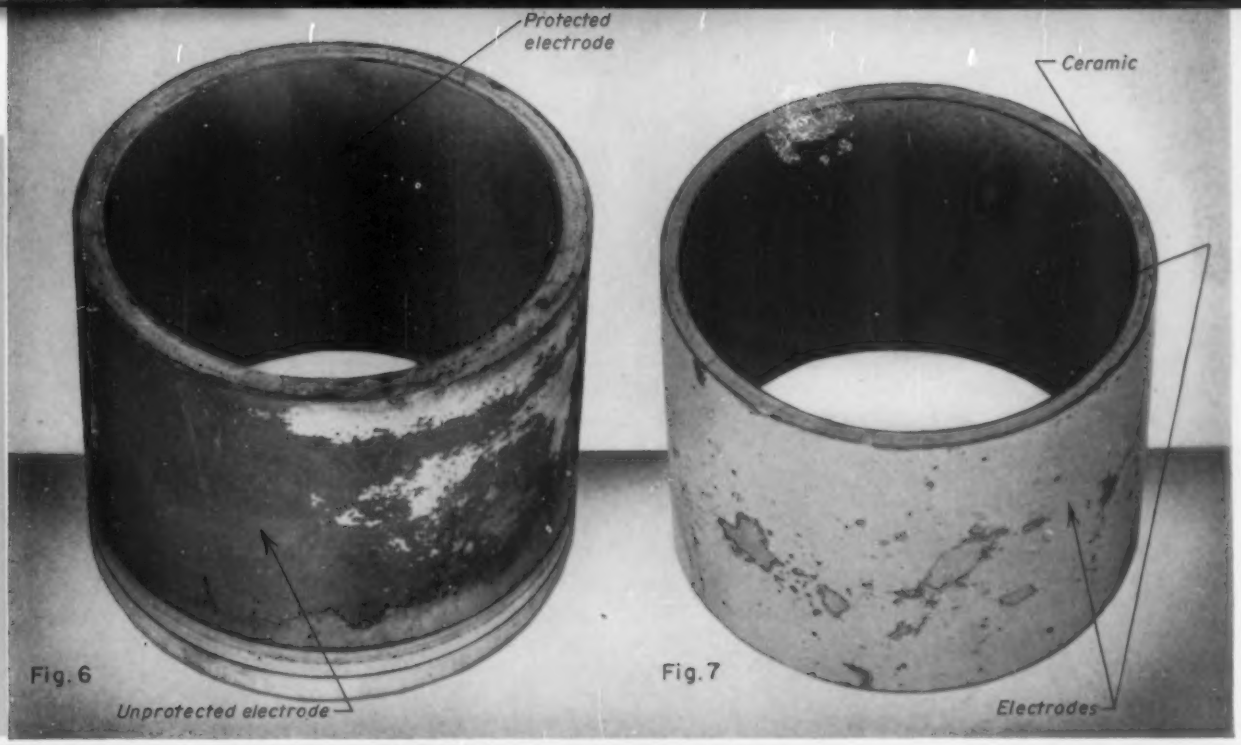


Fig. 6

Fig. 7

at all regular; surface appears white and even shiny on some sections and dull black on others, although the mechanical damage is fairly uniform.

4. Aluminum rod ½ in. dia protected with a 0.015 in. layer of flint-filled epoxy resin; 98 hr at 33 kc. Although the resin was extremely hard and glossy when applied, the cavitation attack was about the same as on bare aluminum. Attack was along lines corresponding to the legs of the cavitation spider. Resin surface was pitted and had a mat finish. Flakes of resin fell to the bottom of the vessels. Microscopic observations showed a large number of small, whitish, crystal-like beads scattered all over the attacked region.

5. Pyrex glass rod ½ in. dia; 102 hr at 33 kc. Damage looks very much the same as on aluminum samples, with deep holes and marked undercuts. The pattern of attack reproduces the shape of the cavitation spider to some extent, but there are also regions of uniform damage with a mat finish.

6. Aluminum rod ½ in. dia with a thin synthetic rubber coating; 17 hr at 33 kc. It took only a short time to break through the rubber layer and attack the aluminum. Here again chemical effect is superimposed on the mechanical damage, forming a pattern of dark regions on the light gray aluminum surface.

7. Beryllium copper rod 3/32 in. dia; 126 hr at 33 kc. Damage consists mainly of chemical change on the surface of the metal which is black and rough. The cavitation holes are similar to the ones observed in aluminum, but there are fewer, concentrated in small regions in the center of the ultrasonic field. With a diameter of only 3/32 in. the screening effect of the cavitation bubbles may explain the reduction in cavitation damage.

8. Hardened steel rod ½ in. dia; 112 hr at 33 kc. Damage consists of holes and dense pitting as well as chemical attack forming a black, hard crust. Only a small portion is iron oxide, the main compound being unidentified. The mechanical damage is much the same as was observed on the other solid rods, except that the holes are smaller, probably due to the greater hardness of steel.

9. Phenolic rod 3/32 in. dia; 222 hr at 33 kc. Mechanical damage similar to other samples; no chemical action was discerned. Mechanical removal of material left densely pitted regions. The holes have the same shape observed before, with pronounced undercuts.

10. Copper-coated steel rod 1/16 in. dia; 100 hr at 33 kc. This test demonstrates the screening effect of cavitation bubbles. Although the total power was the same as for the other tests, the ultrasonic intensity at the surface of the sample was fairly low. Mechanical damage was small, only a few holes, concentrated on lines parallel to the axis of the rod. However, the chemical attack was sufficient to remove the copper layer over the whole immersed length. Most of the sample is covered with a thin, smooth, dark layer of a metallic compound. The damage is very uniform as compared with the other metal rods.

tation field, cavitation spiders, and progress of damage on the metal rod.

The whole system was enclosed in a sound-proof cabinet to protect personnel in the test area. Both cavitation noise and low frequency ultrasound can have a very painful effect on human bodies.

The diameter of the rod tested was just large enough to place its surface at the points of greatest pressure amplitude (Fig. 3). With a larger rod, cavitation would be less intense; if smaller, the cavitation bubbles would act as a protective blanket, reflecting, diffusing, and absorbing sound energy.

Choice of Frequency. Wavelength should be of the same order of magnitude as the diameter of the cylinder since cavitation bubbles will diffuse and absorb ultrasound when the wavelength approaches the bubble size.

It is advantageous, therefore, to choose a mode of vibration giving maximum radial motion of the cylindrical transducer and long wavelength. A 5 in. dia transducer with a length of 4 in. will resonate efficiently in the longitudinal mode (with appreciable radial coupling) at about 20 kc. At this frequency, the wavelength in water is approximately 3 in., much larger than the size of the average cavitation bubble. The screening effect of the bubbles is kept to a minimum and the disturbance near the axis of the cylinder is restricted to a region of very small diameter.

Test Results. Unprotected ultrasonic transducers operating in water will be seriously damaged after only a few hours of intense cavitation. The first cylinder shown in Fig. 6 is 6 in. in diameter and 5 in. high. The outside silver electrode had no special protection; the inside one was protected by a thin layer of special glaze. The cylinder was driven at 17 kc for a total of 250 hr in water. The temperature was kept at about 20 C. The water bath was changed approximately every 30 hr to remove the large amount of silver and ceramic particles suspended in the liquid by cavitation effects, and to keep the amount of dissolved gases in the water constant during the test.

After 27 hr, the unprotected electrode started to peel in large regions and once begun, damage to the unprotected electrode increased rapidly until at the end of the test only 25 per cent of the total electrode area was left on the cylinder. The ultrasonic power output dropped considerably and the test had to be terminated. The inside electrode, protected with the glaze, suffered no apparent damage although microscopic observation did reveal very tiny blue and black spots in the glaze which were not present before the test.

Constant hammering between the ceramic cylinder base and the bottom of the trough, combined with cavitation, produced deep attack on the edge of the transducer. Electrical leads soldered to the electrodes were stranded copper wire connected to the electrodes by lumps of low-melting solder approximately ½ x ½ x ¼ in. The solder itself showed little damage, but the leads were severely attacked, both mechanically and chemically. Strong cavitation increased the oxidation rate of the copper, which was weakened and blackened, and strands were broken. The damage observed on leads was apparently of a different type than for the transducer.

Protection of Electrodes. A protection of glaze was found effective on the large electrodes, as shown in Fig. 7 for a cylindrical transducer after 1,100 hr of cavitation tests at 44 kc. Although the exposure is four times as long as the first test and the ultrasonic intensity was about twice as large, damage to the electrodes appears only on about 5 per cent of the total area.

The glaze is not broken but "ground" away beginning apparently on weak spots, and tiny holes seem to be drilled right through the glaze to the silver electrode underneath. These holes may correspond to the location of small air bubbles in the glaze, since a perfect glaze could not be obtained. Some metallic compound from the silver electrode was brought to the surface of the glaze in tiny, shiny spheres and some other material was diffused under the glaze and built a blue or black halo around the hole. With further test the metallic shiny spheres grew, the hole enlarged and the blue and black diffusion regions extended until both glaze and silver were removed from the ceramic. Then the ceramic itself began to be destroyed at a slow rate. These regions of deep damage are clearly visible in Fig. 7.

Similar tests were performed on ceramic cylinders protected with thin layers of synthetic resins. The results were equally good but the resins reduced the total ultrasonic output appreciably more than the glaze.

Protection of Transducer Edges. Adequate protection can be achieved by supporting the transducer on some resilient material such as small wooden or rubber blocks. The transducer of Fig. 7 was so protected and after 1,100 hr of test there were only a few microscopic pits on its edges.

Protection of Leads and Connections. Solder itself, when applied in big enough lumps, is unaffected by cavitation. Leads may be covered with rubber or soft material and protection is further improved by casting epoxy resin on the whole region where leads are attached to the transducer. Thus, complete electrical insulation is achieved, and the transducer can be immersed in water without electrical losses due to water conduction.

Cavitation Damage to Metals

Various metal rods were submitted to intense ultrasonic cavitation at 33 or 44 kc for various exposure times, with the temperature kept at an average of 20 C. Fig. 8 shows the extent of damage obtained. Attack was deeper and faster in the flaws of the sample.. Cavitation damage was also more pronounced at spots where the surface was rough. These experiments show clearly that the cavitation "spider" has a very important part to play in cavitation damage to the solid rods. In many cases the shape of the cavitation spider, and especially its legs, determine the shape of damage areas of the samples.

While these cavitation damage tests have by no means furnished an explanation of cavitation phenomena or their destructive effects on solid materials, the method can supply data on the comparative resistance of materials to cavitation damage.

No material can withstand hammering of cavitation for long before real damage occurs. Damage from cavitation is not only mechanical destruction, but concurrent chemical action causes profound changes in metals such as steel, copper, beryllium copper, and aluminum. The nature of these chemical reactions was not established. A glaze was found effective in extending the life of ceramic transducers by several thousand hours; similar protection for metals may yet be developed.

EDITOR'S NOTE—For a further discussion of mechanical-electrical transducers, see "Piezoelectric Ceramics," by Paul L. Smith, in *Product Engineering*, October 1954, starting on page 161.

Additional applications of ultrasonics are described in "Putting Ultrasonics to Work," by Boyd Wise and Dale Ensinger, in *Product Engineering*, August 1952, starting on page 180.

A discussion of cavitation effects on venturi tube operation was included in "Theory of Hydraulic Flow Control" by Nils M. Sverdrup in *Product Engineering*, April 1955, on page 172.

PRODUCT DEVELOPMENT, a running start

There are many reasons for initiating a product development project, some of the most important follow:

- Create a need and develop a new market.
- Meet an existing marketing need.
- Exploit research and technological advances.
- Meet changing customer needs or desires.
- Diversify the existing products and markets.
- Increase coverage of an existing product line.
- Meet competitive performance.
- Meet competitive pricing.
- Obtain competitive advantages.
- Modernize or restyle a product or line.
- Take advantage of improved manufacturing processes or facilities.
- Reduce the selling price and expand sales volume.
- Reduce manufacturing cost of the product and obtain a better profit margin at existing price levels.

An efficient and well-organized Product Planning Committee is indispensable for the proper supervision of a new product development. The Committee controls the accumulation of data, determines performance specifications, estimates sales volume and selling price on the basis of cost studies, and guides the design toward the expected service life of the product.

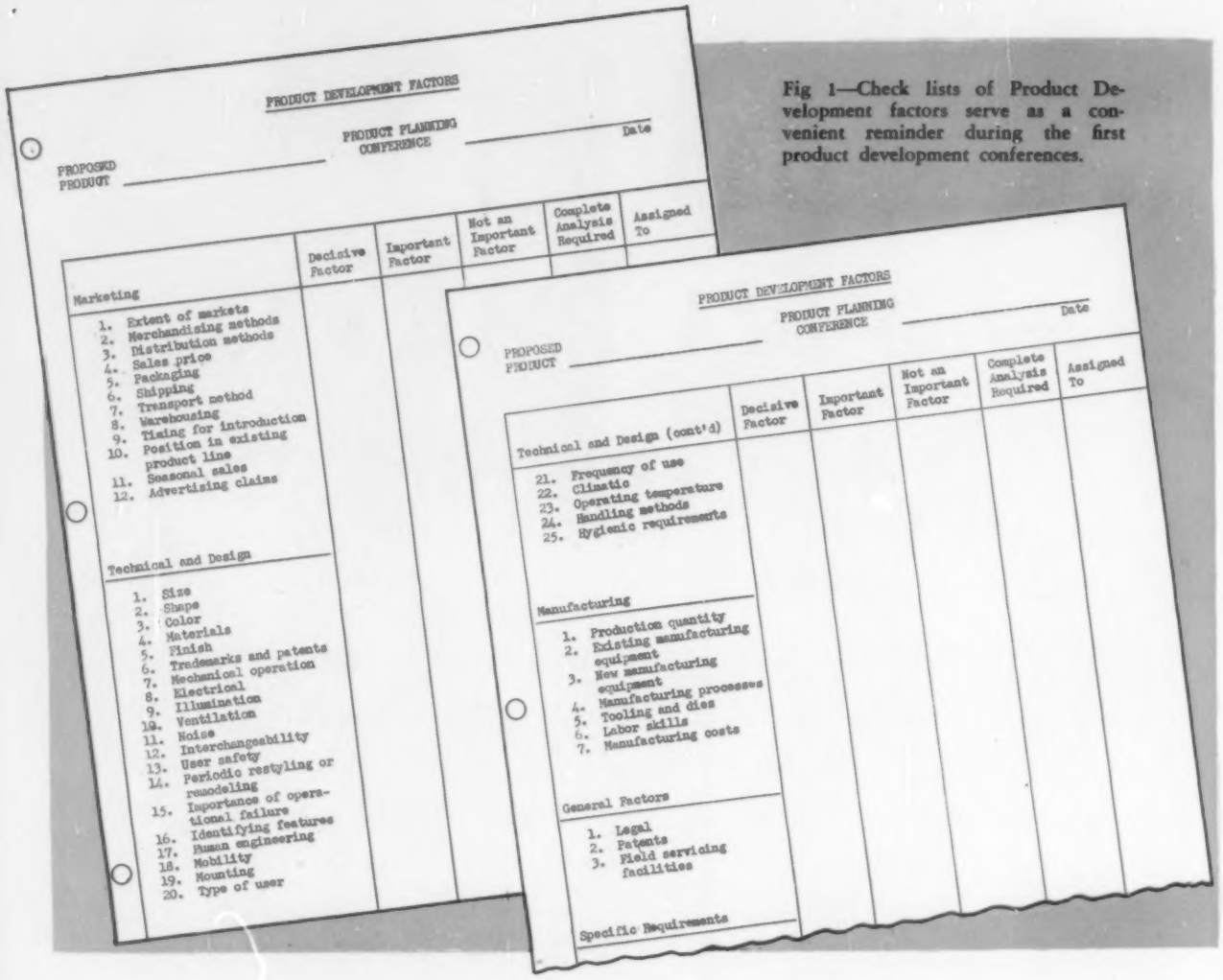
R. R. ALLEN
Director of Engineering, Bennett Pump Division, John Wood Company

MODERN DESIGN and development is aimed at producing a product of satisfactory quality, performance, and cost, to enable it to be sold in volume at a profit. It is to the interest of the entire organization to have suitable products, but it is particularly the joint function of the Development Engineering and Marketing Division to develop these products.

The satisfactory completion of a product development project depends upon the teamwork of all parties involved. The day of the independent inventor who presented his product to the company ready for production has passed. Now it is a rare individual who can understand all the different sciences and technologies which are represented in even the simplest of products.

Product planning is such a complex subject and crosses so many functional and departmental lines that most companies form a product planning committee which is responsible for plotting the course of new product development. A committee serves to formalize the product development function and representatives of the various departments are given an opportunity to be heard. The committee makes recommendations as to further information required and makes decisions regarding product desirability based on surveys, market searches, preliminary research, estimated engineering costs, and tentative specifications.

Membership on the product planning committee will vary depending upon the type of products manufactured, company policy and size of the organization. Often the committee is headed by a full-time Director of Product



PRODUCT DEVELOPMENT FACTORS

PROPOSED PRODUCT _____ PRODUCT PLANNING CONFERENCE _____ Date

	Decisive Factor	Important Factor	Not an Important Factor	Complete Analysis Required	Assigned To
Marketing					
1. Extent of markets					
2. Merchandising methods					
3. Distribution methods					
4. Sales price					
5. Packaging					
6. Shipping					
7. Transport method					
8. Warehousing					
9. Timing for introduction					
10. Position in existing product line					
11. Seasonal sales					
12. Advertising claims					
Technical and Design					
1. Size					
2. Shape					
3. Color					
4. Materials					
5. Finish					
6. Trademarks and patents					
7. Mechanical operation					
8. Electrical					
9. Illumination					
10. Ventilation					
11. Noise					
12. Interchangeability					
13. User safety					
14. Periodic restyling or remodeling					
15. Importance of operational failure					
16. Identifying features					
17. Human engineering					
18. Mobility					
19. Mounting					
20. Type of user					

PRODUCT DEVELOPMENT FACTORS

PROPOSED PRODUCT _____ PRODUCT PLANNING CONFERENCE _____ Date

	Decisive Factor	Important Factor	Not an Important Factor	Complete Analysis Required	Assigned To
Technical and Design (cont'd)					
21. Frequency of use					
22. Climatic					
23. Operating temperature					
24. Handling methods					
25. Hygienic requirements					
Manufacturing					
1. Production quantity					
2. Existing manufacturing equipment					
3. New manufacturing equipment					
4. Manufacturing processes					
5. Tooling and dies					
6. Labor skills					
7. Manufacturing costs					
General Factors					
1. Legal					
2. Patents					
3. Field servicing facilities					
Specific Requirements					

Fig 1—Check lists of Product Development factors serve as a convenient reminder during the first product development conferences.

Development. Marketing and technical functions and top management must necessarily be represented on the committee. Other functions of the company such as finance, legal, manufacturing, and purchasing should be represented if they can make a real contribution to product planning. Every effort should be made to keep the size of the committee to the minimum necessary to do the job.

Type of projects referred to the committee is a major element in making a product planning committee work. Obviously the committee cannot consider every small product improvement project. A project planning committee should *not* be concerned with minor cost reduction changes, minor technical improvements, changed processing to utilize new manufacturing methods, or other small designs which are evolutionary in nature and serve to maintain the competitive position of existing products.

The product planning committee *should* take an active part in new product development, major modifications to existing products, additions to the existing line such as standard or deluxe models of a product, major variations in a product to meet a customer's requirements, and any other developmental or sales projects which will result in a major change in the line of products.

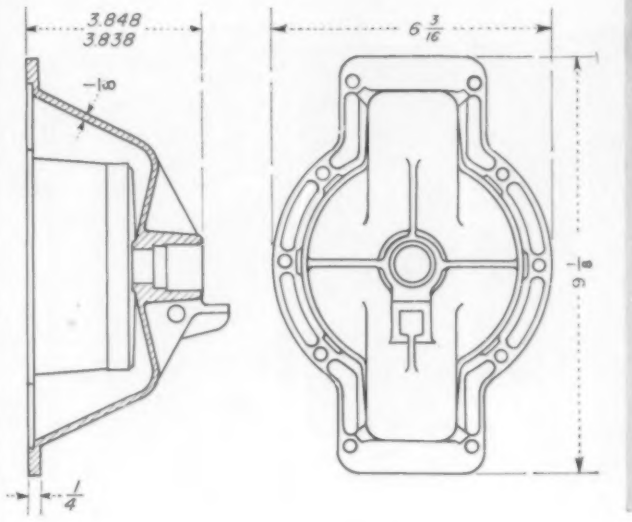
The product planning committee serves as a board to review progress on projects and to consider changes in specifications and preliminary estimates which may be required as a project progresses. It makes the final evaluation of the execution of the product development project in its marketing, technical, and manufacturing phases.

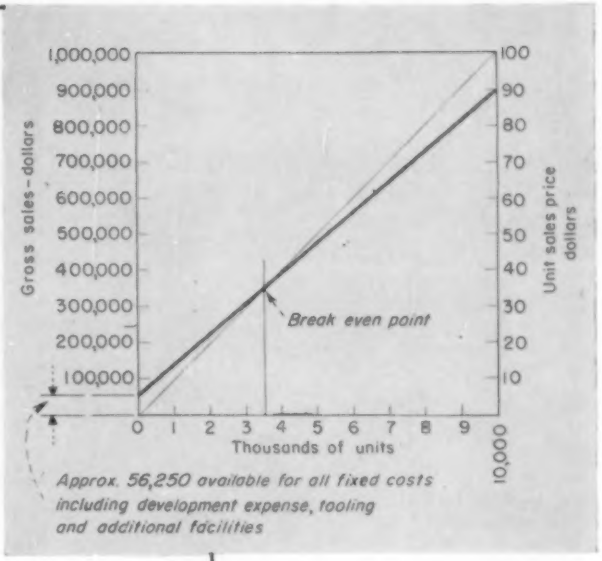
Preliminary Product Planning

It is unlikely that all of the information necessary for a preliminary marketing and technical investigation will be available at the time when the new product development is first considered. Much of the information may have to be obtained as the preliminary investigation progresses. It is desirable to hold a preliminary product development conference as soon as possible after the project has been put up for consideration. A check list is usually of considerable help in suggesting important factors at this conference, and also may assist in assigning responsibility for gathering necessary information.

The check list shown in Fig. 1 lists a considerable number of points. At the first consideration of the development project it is only necessary to decide which of these factors is important and what information must be obtained before the project can proceed. Assignment of responsibility for obtaining this information may also be made at this time.

Should sufficient information be available at the pre-




Gross sales - dollars
Unit sales price dollars
Break even point
Thousands of units
Approx. 56,250 available for all fixed costs including development expense, tooling and additional facilities

COST ANALYSIS

Estimated production 2,500 pieces

Die Casting		Sand Casting	
Estimated Tooling Cost	$5,500.00	Estimated Tooling Cost	$1,500.00
raw casting	0.630	raw casting	1.200
direct labor cost	0.044	direct labor cost	0.163
factory burden	0.133	factory burden	0.490
tooling burden	2.200	tooling burden	0.600
piece price	3.007	piece price	2.453

Estimated production 50,000 pieces

Die Casting		Sand Casting	
Estimated Tooling Cost	$5,500.00	Estimated Tooling Cost	$1,500.00
raw casting	0.630	raw casting	1.150
direct labor cost	0.044	direct labor cost	0.163
factory burden	0.133	factory burden	0.490
tooling burden	0.111	tooling burden	0.333
piece price	0.918	piece price	2.136

Fig 2—A Break-Even Chart can be invaluable in determining the economic feasability of a new product.

Fig 3—Accurate volume information is essential in selecting the best production process.

liminary product planning conference it may be possible to obtain a good graphical analysis from a break-even chart, as shown in Fig. 2. As an example, suppose the very first estimates show the following:

Estimated total volume = 10,000 units
Probable sales price = approx. $100/unit
Required net profit (determined by management policy) = 10%
Desired break-even-point (may be based on estimated yearly sales and management policy) = 3500 units

A chart can be constructed which will determine the amount of money available for product development, tooling and new facilities. While a chart based upon estimated information is necessarily an approximation, it shows whether the conditions are utterly impossible of attainment or whether based upon past experience the money for product development is grossly inadequate.

If the amount of money which the company is willing to spend for product development and fixed costs is estimated, it is, of course, possible to use the chart to determine the break-even point.

Required Product Development Information

Before the Engineering Department can proceed with the first phase of the product development project certain basic marketing and technical information must be at hand. It is impossible to outline all of the information which may be required because it will vary depending upon product, marketing policies, manufacturing facilities and distribution. Most of this information must be gathered and analyzed by the Marketing Division.

Tentative performance specifications can be developed

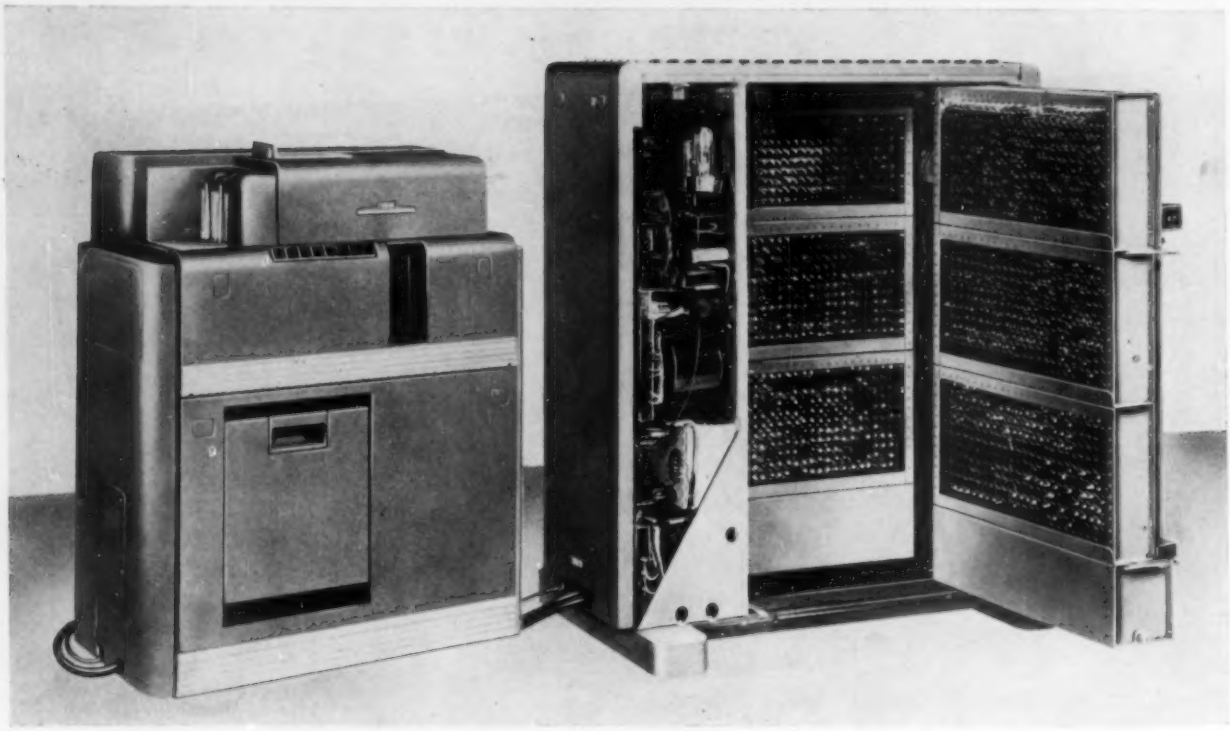


Fig. 4—IBM Electronic Calculator (Type 604) contains 1400 electron tubes and requires factory trained service personnel.

from a comparison chart of existing and competitive equipment and from market research, customer questionnaires, service reports and other sources. It may even be necessary to assume certain specifications in order to get the development under way. Assumed specifications, however should be checked as soon as possible to determine their correctness and to keep the development project from wandering too far astray even in the first phase. Specifications should be reduced to a standard form if at all possible.

Those specifications which are costly to achieve or are required for a very limited portion of the total market should be especially examined for economic justification. For example, it is sometimes quite costly to maintain product performance at sub-zero temperatures. It would probably not be economical to manufacture a product which would operate in sub-zero temperature if 95 per cent of the sales were in climates of moderate temperature. In this case the manufacturing of two models, a standard model and low temperature model might be considered. The loss of a small portion of the market might produce a better overall project from a profit standpoint due to lower cost of the standard product.

Estimated yearly sales volume and the total volume expected to be sold before major redesign are two important factors in determining the most suitable and economical manufacturing processes for the product. The product design will, of course, be greatly influenced by the production processes available.

The production methods capable of highest production and lowest piece cost are usually the methods requiring the highest investment in tools and equipment. The final selection of method of manufacture is usually a compromise between the method given the lowest piece price and highest tool investment and the method giving somewhat higher piece price but a lower tool investment. Making the correct selection depends upon accurate sales volume estimates. Fig. 3 is an example of this compromise.

Capital investment in production machinery and factory space must be amortized over a predetermined production quantity of the product or over a certain period of years as determined by the policy of the company and tax regulations. There is a charge to each unit of the product for this tooling and capital investment amortization.

The total amount of money available for manufacturing must be reduced by the capital investment amortization charge. This factor is important in making preliminary break-even charts.

Experience with similar products, market research, sampling service, competitive product sales volume, and other marketing research techniques may supply sufficiently accurate sales volume estimates to get the development under way. If this sales information is not forthcoming an assumption of volume must be made. It should be thoroughly and continuously checked by factual information before the first phase of the product development project is completed.

The competitive comparison is used to evaluate the features and prices of competitive products and to determine if the tentative specifications and features of the proposed product will give a product which offers features at a price to capture a suitable portion of the competitive market.

It is very desirable to have actual models of competitive products. These may be given rigorous quality and performance tests to determine if their features are really desirable and to assess the overall quality of the product.

Special performance or sales features may be required or desirable and they should be decided upon early in the

project. In many cases the addition of small features will give a definite edge over the competitive product. Trends in design such as the increased use of plastics and stainless steel decorative trim are design features which will have a direct effect upon the product engineering and the product cost. Whether these features will be sold on a deluxe model basis or as optional equipment at extra cost are important factors.

Periodic styling or feature changes offer an easy way of obsoleting a product and giving the Marketing Division an opportunity to appeal to that portion of the market which always wants to own the latest design. Changes in trim and moldings and minor features can often be used to alter the appearance of a product quite considerably. These changes can frequently be made without altering the basic design if the necessary provisions are made early in the productive development project. If it is anticipated that a product will be marketed for a certain number of years before a major design change is attempted and that small styling alterations will be made each year, then the first design should provide for these styling changes.

Relation of product to present product line. Will the new product be an extention of the present product line or will it be entirely new and perhaps establish a new product line? In the case of an extension of the product line, is the design of the product to conform to the rest of the line in styling and performance? Perhaps the new product should have as many advanced features and styling as possible and so form a pattern for an evolutionary redesign of the rest of the line.

The entirely new product permits much greater freedom of design but also presents more difficult problems in evaluating appearance and features. The entirely new product will be more likely to require additional manufacturing space and new equipment and perhaps new personnel of different skills.

Many parts and assemblies used in existing products can frequently be used in the design of the new product, especially if it is intended that it shall fit into a predetermined niche in the present product line. This may result in a substantial reduction in cost of tools and machinery. It also promotes standardization and simplifies field servicing and parts stock. However, if the new product is to establish a new product line, or is to fit into the present product line but is to form the pattern for a complete redesign of the line, then it may be well to avoid standardizing on existing parts without thoroughly rechecking them for function, cost, and adaptability.

Standard and Deluxe models are a frequent answer to the problem of supplying several classes of consumers and still maintaining a single basic design. The deluxe model may have genuine utilitarian features or it may be different only in the decoration and appearance. If the product is to comprise a line of standard and deluxe models, then estimates must be made of the selling price differentials.

Underwriters' Laboratories or National Board of Fire Underwriters approval are usually required on products which may involve a fire hazard. A Weight and Measures seal is required for most products that are used to dispense a commodity to the public. There are other regulatory authorities, laws and sometimes trade association standards which must be met before a product can be marketed. Early in the development, the legal restrictions should be determined and provisions made for meeting the applicable standards. If necessary, preliminary submittals may be made to legal or regulatory authorities to obtain tentative approvals where there may be a question of acceptance. Tentative approval may save the cost of redesigning a product to meet unanticipated requirements and result in an earlier completion of the product development project.

Required service life of the product is an important consideration if overbuilding or underbuilding is to be avoided. Overbuilding results in too high a selling price or reduced profits or both. Underbuilding causes customer dissatisfaction and loss of good will. Such pertinent questions must be asked as:

Will the product be in use on a continuous basis or intermittent? How many months or years should the product be expected to perform? What is the estimated use in hours or days per year?

How serious is a product failure? Would personnel be endangered? Is important loss of financial return the result of failure? Is service available in case of failure?

The answers to these questions determine many of the laboratory and field tests which are made before the product is released for production and distribution.

Type of maintenance service which will be used. There are several ways of servicing the product for the customer. The two major procedures are: service by authorized trained maintenance men only and service by local mechanics or general shops.

When the product is leased or rented to the customer the servicing and repairs are usually handled by trained personnel. This permits an excellent control of service procedures and has a direct influence on design of the product. Trained personnel can be more readily depended upon for complex servicing jobs. They will be aware of the latest factory procedures and will have the latest factory service bulletins. With this type of maintenance service, more complex mechanisms and products can be designed. Trained servicemen will also be more reliable in transmitting product complaints and malfunctions to the factory. This information can be of considerable value in future designs and in engineering changes.

When the product must be serviced by local shops or personnel not directly trained in servicing the product, the design must provide for minimum and simplest possible servicing, even at the expense of increases in manufacturing cost. It may be desirable to consider component replacement rather than actual field repair. Components may be designed for easy interchangeability by untrained personnel. Components are then returned to the factory or a central service point for repair.

EDITOR'S NOTE—For another article on new product development see "The Fine Points in a Product Development Program" by George Kendall, in *Product Engineering*, January 1953.

A more detailed description of break-even charts may be found in an article entitled "Break-Even Charts" by W. A. Schuette, in *Product Engineering*, August 1953.

A special report on the role of research in product development entitled "Insuring Your Progress Through Research", appeared in the June 1953 issue of Product Engineering starting on page 171. While the supply lasts, single copies of this 32-page report will be supplied without charge on letterhead request.

Selecting Vibration Isolators

DESIGN PROCEDURE.

RUSSELL LOWE, ASS'T CHIEF ENGR.,
BARRY CONTROLS INCORPORATED

1. Locate approximate center of gravity of equipment to be isolated.

2. Determine location of the isolators on the equipment (see illustrations). For optimum isolation and prevention of coupled resonance, isolators should be located in a plane passing through the center of gravity of the equipment. A further refinement is to make distances x and y equal to the radius of gyration about their respective axes.

3. Measure or compute static load w on each isolator position.

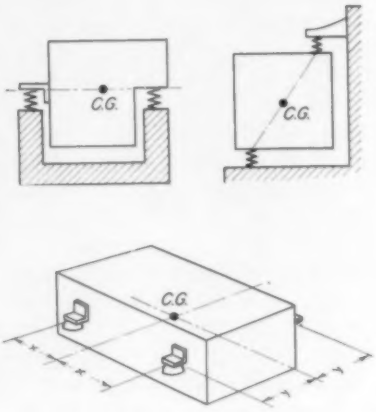
4. Measure the disturbing frequency f (usually equal to operating speed of machine).

5. Determine the desired vertical natural frequency f_n of isolated system. The ratio f/f_n should be as large as possible with a minimum value of 2.5. Since disturbing frequencies are usually 1,800 rpm (30 cps) or above most isolators are designed to produce a natural frequency of 8-10 cps at rated loads.

The natural frequency can be computed from the equation:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{Kg}{w}}$$

where K is the spring rate of isolator at load w, and g is the acceleration of gravity.



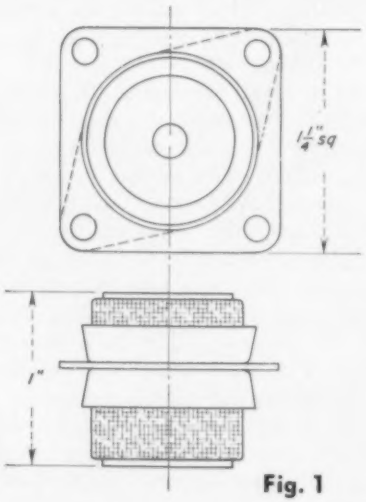


Fig. 1

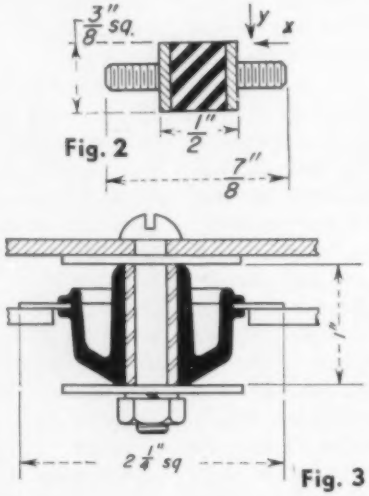


Fig. 2

Fig. 3

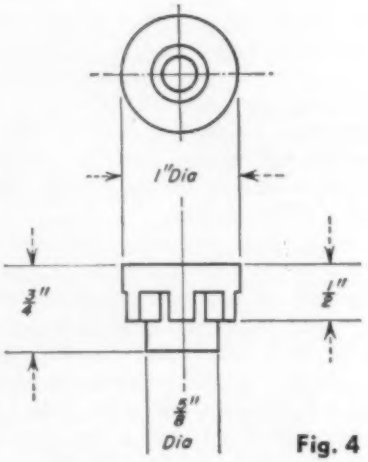


Fig. 4

FIG. 1—Cushion of woven wire acts as a resilient load-carrying spring and has good damping characteristics. Particularly adaptable for the mounting of sensitive electronic equipment in cramped spaces. Load range: ¼ to 2½ lb; effective isolation at disturbing frequencies of 40 cps or higher. *Robinson Aviation Inc.*

FIG. 2—Lightweight motors, instruments and controls can be easily installed with insolators composed of studs bonded to rubber. Rubber is in compression in x-direction and in shear in y-direction. Load range in y-direction: up to 4½ lb; $f_n = 8$ cps at maximum load. *Barry Controls Incorporated.*

FIG. 3—Equal stiffness in all directions is obtained by rubber mount strained in shear when loaded in any direction. Used for isolation of instruments subjected to significant disturbing frequencies in more than one direction. Load range: up to 45 lb; $f_n = 10$ cps (approx). *Lord Manufacturing Co.*

FIG. 4—Grommet-type small isolators used on fans, phonograph turntables, instruments. Inexpensive and easy to install. Material: neoprene; durometer hardness influences its spring constant. Available in several degrees of hardness. Load range: up to 120 lb. *The MB Manufacturing Co., Inc.*

FIG. 5—For isolation of lightweight instruments and electronic equipment especially in aircraft. All-metal construction permits operation under high temperatures. Damping is obtained by a knitted stainless steel wire core. Load range: up to 3 lb; $f_n = 8$ cps at maximum load. *Barry Controls Incorporated.*

FIG. 6—Outer cushions of knitted monel wire restrict deflec-

Five-point design procedure for the general case of disturbing amplitudes in the vertical direction. Eleven typical isolators covering loads from ounces to tons and employing woven wire, rubber in shear and compression, conical springs with air damping, and combinations of wire mesh and springs.

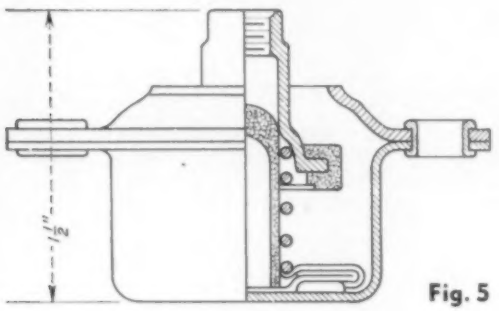


Fig. 5

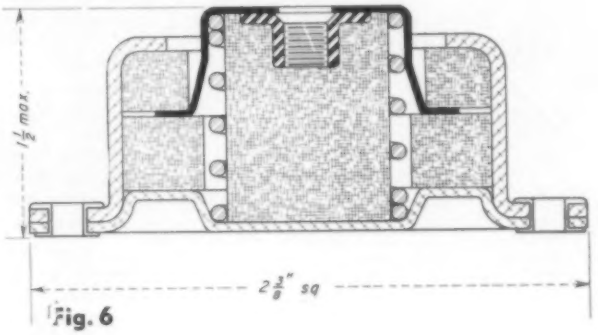


Fig. 6

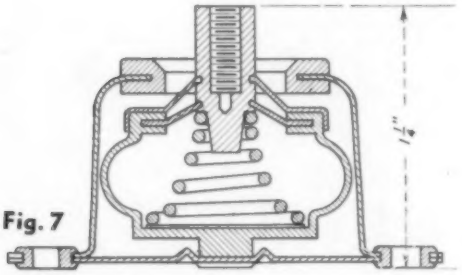


Fig. 7

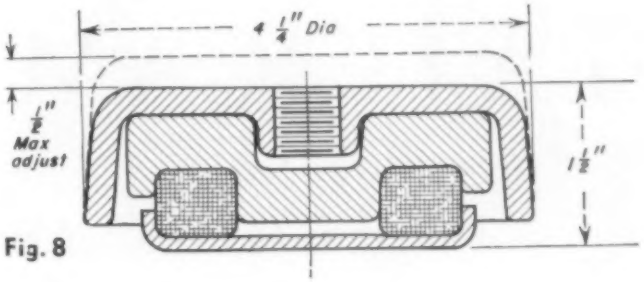


Fig. 8

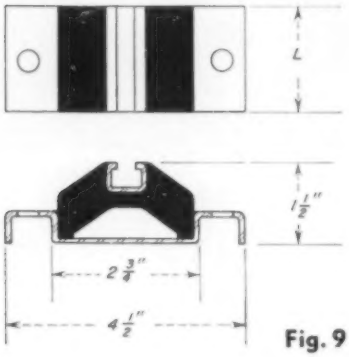


Fig. 9

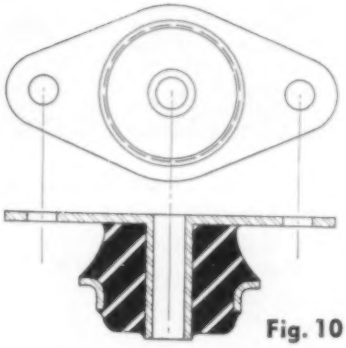


Fig. 10

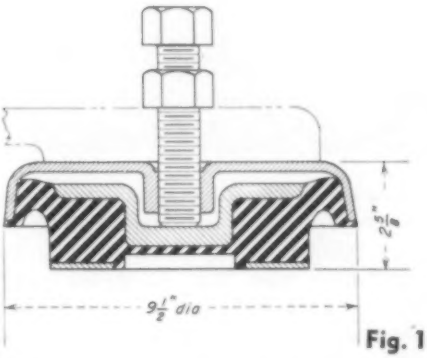


Fig. 11

tion while stainless steel spring and inner cushion give non-linear spring characteristics. Used on lightweight machine tools and laboratory equipment. Load range: up to 130 lb. *Robinson Aviation Inc.*

FIG. 7—Conical spring provides necessary resilience while air damping is obtained by air forced through small orifices in bellows during vibration of isolator. For light airborne electronic instruments. Load range: up to 35 lb; $f_n = 8$ cps (approx). *Barry Controls Incorporated.*

FIG. 8—Industrial machinery mounting has adjustment for leveling and alignment. Uses a stainless steel wire mesh without springs. Applications are in machine tools whose operating speed is 1,750 rpm or higher or 350 strokes per minute or less. Lagging to floor unnecessary. Load capacity: up to 4,000 lb. *Robinson Aviation Inc.*

FIG. 9—Channel-type rubber mounts have load range up to 400 lb depending upon length of channel which varies from 1 to 8 in. Typical applications are light stationary engines and machine tools, compressors and commercial refrigerators. *Lord Manufacturing Co.*

FIG. 10—Vibration mount, designed to stress rubber in both shear and compression when loaded, has almost equal spring rate in all directions. Load range: up to 1,000 lb. Used on combustion engines and heavy electronic equipment. Dimensions vary with load range. *The MB Manufacturing Co., Inc.*

FIG. 11—Heavy-duty mount for machine tools has load range up to 13,000 lb and can be adjusted for leveling. Does not require lagging to floor even when used under heavy presses. Machines can be easily relocated for optimum work flow; $f_n = 10$ cps at max load. *Barry Controls Incorporated.*

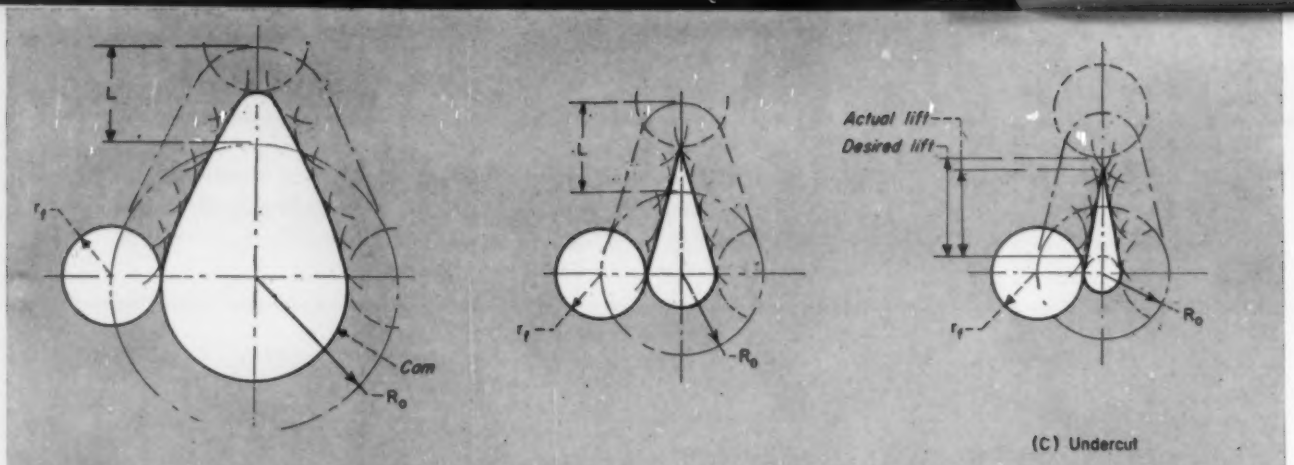


Fig. 1—Effect of cam size on pressure angle and radius of curvature. As a cam is made progressively smaller while maintaining constant lift, follower roller radius, and total angular rotation of cam over the event, undercutting will eventually take place, as in *(C)*. This can also occur if follower roller radius r_f is increased progressively while the follower center path is held constant.

PLATE CAM DESIGN

. . . radius of curvature

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As a cam of given lift is made successively smaller, its over-all shape changes significantly. The pressure angle increases and the radius of curvature at the apex of a rise approaches zero, Fig. 1. If the size is decreased further, the apex is undercut, resulting in reduced lift and the original motion curve is no longer followed.

To prevent undercutting, r_f, the follower radius, must be less than ρ_{min}, the minimum radius of curvature over the segment under study. If the cam has several separate motion curves, each must be checked separately because only one segment can be represented by a continuous function. However, only convex surfaces need be tested because it is impossible to undercut a concave curve, Fig. 2, and because contact stresses for a given normal force are always smaller in the concave areas.

The follower center path is usually described in polar coordinates, R, the radius measured from the cam shaft center to the roller follower center, against ϕ, angular rotation of cam measured from a line joining the follower roller center and cam center. For the segment under consideration, it is assumed (1) a functional relationship exists between R and ϕ, for example, $R = G(\phi)$ and (2), first two derivatives of function are continuous:

$$dR/d\phi = G'(\phi) \quad \text{and} \quad d^2R/d\phi^2 = G''(\phi)$$

From the calculus, the radius of curvature is:

$$\rho = \frac{\left[R^2 + \left(\frac{dR}{d\phi}\right)^2\right]^{3/2}}{R^2 + 2\left(\frac{dR}{d\phi}\right)^2 - R\frac{d^2R}{d\phi^2}} = \frac{\left\{[G(\phi)]^2 + [G'(\phi)]^2\right\}^{3/2}}{[G(\phi)]^2 + 2[G'(\phi)]^2 - G(\phi)G''(\phi)} \qquad (1)$$

RADIAL FOLLOWER SYSTEM

Usually a cam design begins with a timing diagram, which prescribes one or more functional relationships between output displacement and time. Since most cams are driven at constant angular velocity, this relationship is readily converted to $y = F(\theta)$, output displacement versus angular rotation of the cam.

Output displacement can be either rotational or translational. For translation, the simplest condition is the radial follower. In Fig. 3, L, the cam lift equals h, the total output displacement. Therefore,

$$R = R_o + y = f(\theta)$$
$$dR/d\theta = f'(\theta)$$
$$d^2R/d\theta^2 = f''(\theta)$$

where $f(\theta)$ is a harmonic, cycloidal, or other relationship.

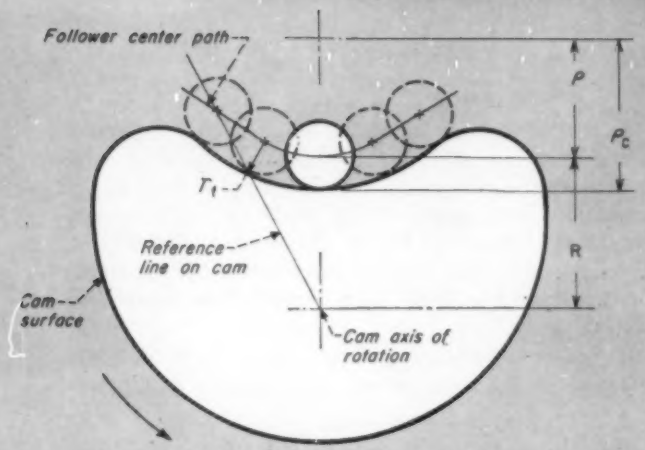
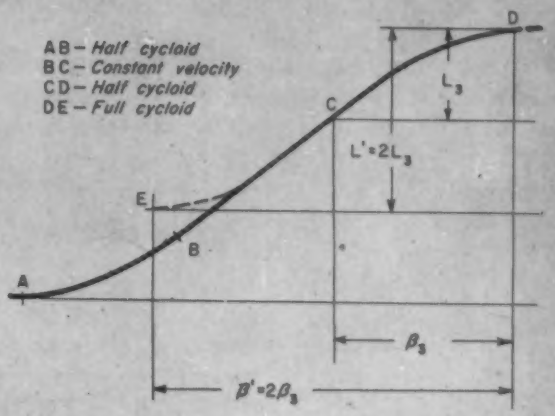


Fig. 2—In a concave portion of a cam, ρ_c, the radius of curvature of the cam, must always be greater than ρ, the radius of curvature of the following center path. If this condition is fulfilled, there is no danger of undercutting.

Fig. 4—Timing diagram for cam rise combining several curve sections. Symbols refer to radial cam follower system, but same principle applies to swinging follower. For the latter, replace L with τ, the angular displacement of follower arm. See text for details of solution.



This is the third part of a series on cam design. Blending of profile curves was discussed in February 1955, page 156. Next was a pressure angle analysis, May 1955, page 155. Herein is a study of radius of curvature, including a comprehensive set of design charts developed with the aid of automatic computing equipment. The minimum radius of curvature must be calculated (1) to prevent undercutting and (2) to keep surface stresses within allowable limits.

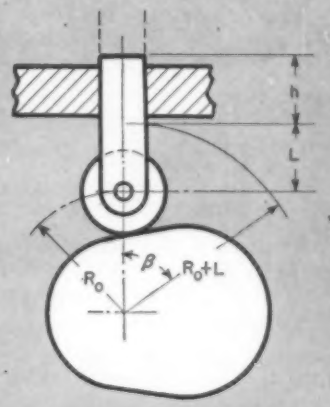


Fig. 3—Radius of curvature geometry for the radial cam follower system.

Since the follower center does not rotate with respect to the cam center, $\theta = \phi$, $f(\theta) = G(\phi)$, $f'(\theta) = G'(\phi)$ and $f''(\theta) = G''(\phi)$. See Fig. 6 for definition of θ and ϕ.

Substituting $f(\theta)$, $f'(\theta)$, and $f''(\theta)$ in Eq (1):

$$\rho = \frac{\left\{[f(\theta)]^2 + [f'(\theta)]^2\right\}^{3/2}}{[f(\theta)]^2 + 2[f'(\theta)]^2 - f(\theta)f''(\theta)} \qquad (2)$$

Then, the expression for $f(\theta)$, $f'(\theta)$, and $f''(\theta)$, which correspond to the desired motion can be substituted in Eq (2). For cycloidal motion, for example, the functions are

$$f(\theta) = R_o + h\left(\frac{\theta}{\beta} - \frac{1}{2\pi}\sin 2\pi\frac{\theta}{\beta}\right)$$

$$f'(\theta) = \frac{h}{\beta}\left(1 - \cos 2\pi\frac{\theta}{\beta}\right)$$

$$f''(\theta) = \frac{2\pi h}{\beta^2}\left(\sin 2\pi\frac{\theta}{\beta}\right)$$

For harmonic motion

$$f(\theta) = R_o + \frac{h}{2}\left(1 - \cos\pi\frac{\theta}{\beta}\right)$$

$$f'(\theta) = \frac{\pi h}{2\beta}\left(\sin\pi\frac{\theta}{\beta}\right)$$

$$f''(\theta) = \frac{\pi^2 h}{2\beta^2}\left(\cos\pi\frac{\theta}{\beta}\right)$$

When these expressions are substituted in Eq (2), the resulting equation can be differentiated to locate the value of θ corresponding to the minimum value of ρ. But, since this leads to a cumbersome transcendental expression, the problem has been solved with a computing machine. Using a given set of parameters β and L/R_o and a given motion curve, a value of ρ/R_o was calculated for each value of θ from zero to β and the minimum value chosen. This was done for values of parameters β and L/R_o and for cycloidal, harmonic, and eighth power polynomial profiles. The resultant minimums have been plotted in Figs. 7 through 12.

EXAMPLE 1

For a radial follower mechanism like that of Fig. 3, the following data are given: $r_f = 0.1875$ in., $L = 0.200$ in., and $\beta = 20$ deg, and the motion is cycloidal.

First Solution

Assuming $R_{max} = 1.250$ in., $R_o = R_{max} - L = 1.050$

in and $L/R_o = 0.19$.

From Fig. 8, for $L/R_o = 0.19$ and $\beta = 20$ deg, $\rho_{min}/R_o = 0.16$. Then,

$$\rho_{min} = (0.16)(R_o) = 0.17 \text{ in.};$$
$$\rho_c = \rho_{min} - r_f = (-0.02) \text{ in.}$$

This cam would be undercut because $r_f > \rho_{min}$ and therefore ρ_c is negative.

Second Solution

A larger value of maximum radius, $R_{max} = 1.500$ in. is chosen. Thus, $R_o = 1.300$ in.; and $L/R_o = 0.155$.

In Fig. 8, for $L/R_o = 0.155$, and $\beta = 20$ deg, $\rho_{min}/R_o = 0.17$. Then,

$$\rho_{min} = 0.22 \text{ in.};$$
$$\rho_c = 0.03 \text{ in.}$$

This cam would not be undercut, but it would be advisable to make some further adjustment. These are the possibilities:

(1) Increase R_{max}, which is the most desirable if space permits.

(2) Increase β at the expense of other events in the cycle.

(3) Reduce the roller diameter, if stud and bearing capacities will permit.

EXAMPLE 2

For a mechanism like that of Fig. 3, and the timing diagram of Fig. 4, $r_f = 0.1875$ in., rise of cam in segment $L_3 = 0.100$ in., and cam angle $\beta_3 = 10$ deg. Since cam segment AB is concave, the critical area, insofar as radius of curvature is concerned will occur at some point on curve CD.

Solution

Assume $R_{max} = 1.500$ in. Since the charts are constructed for a full curve, half-cycloidal CD must be converted to full cycloid ED. The procedure is analogous to that used in the previous installment for pressure angle calculations.

$$L' = 2L_3 = 0.200 \text{ in.}$$
$$\beta' = 2\beta_3 = 20 \text{ deg}$$
$$R_o' = R_{max} - L' = 1.300 \text{ in.}$$
$$L'/R_o' = 0.155$$

Using L', β' and R_o' to enter the charts, the computation proceeds as in the previous example. In Fig. 8, for $L'/R_o' = 0.155$ and $\beta = 20$ deg;

$$\rho_{min}/R_o' = 0.17$$
$$\rho_{min} = 0.22 \text{ in.}$$
$$\rho_c = 0.03 \text{ in.}$$

As in Example 1, this cam would not be undercut, but it might be desirable from the standpoint of surface stress to increase ρ_c. This can be done by one of the three methods described in the previous example.

SWINGING FOLLOWER SYSTEM

In this system, Fig. 5, the follower rotates about some center B through angle γ, the output displacement.

From the figure

$$\delta_o = \cos^{-1}\left(\frac{l^2 + c^2 - R_o^2}{2lc}\right) \quad (3a)$$

$$\delta = \delta_o + \gamma \quad (3b)$$

$$R^2 = l^2 + c^2 - 2lc\cos\delta \quad (3c)$$

As the follower swings up, the ray from the cam center to the follower center will shift slightly. Hence $\phi \neq \theta$. In deriving the relationship between ϕ and θ, the follower center has been rotated θ deg about the cam for purposes of illustration in Fig. 6. In practice, the follower center is usually fixed and the cam rotates. For the condition shown in Fig. 6(A), cam rotation "away from" the follower pivot,

$$\phi = \theta + \psi_o - \psi \quad (4)$$

For cam rotation "toward" the follower pivot, Fig. 6(B)

$$\phi = \theta + \psi - \psi_o \quad (5)$$

Angles ψ_o and ψ can be computed from Fig. 5.

$$\psi_o = \cos^{-1}\left(\frac{R_o^2 + c^2 - l^2}{2R_o c}\right) \quad (6)$$

$$\psi = \cos^{-1}\left(\frac{R^2 + c^2 - l^2}{2Rc}\right) \quad (7)$$

By definition, R is a function of θ; Eqs (4), (6), and (7) show that ϕ also is a function of θ: $\phi = g(\theta)$

To determine $dR/d\phi$

$$dR/d\phi = \frac{dR/d\theta}{d\phi/d\theta} = \frac{f'(\theta)}{g'(\theta)} \quad (8)$$

Differentiating Eq (3c) $\frac{dR}{d\theta} = f'(\theta) = \frac{lc}{R}\frac{d\delta}{d\theta}\sin\delta$ (9)

Differentiating Eq (3b), $\frac{d\delta}{d\theta} = \frac{d\gamma}{d\theta}$ (10)

Therefore, from Eqs (9) and (10)

$$f'(\theta) = \frac{lc}{R}\frac{d\gamma}{d\theta}\sin\delta \quad (11)$$

Differentiating Eq (4) and (5)

$$\frac{d\phi}{d\theta} = g'(\theta) = 1 - \frac{d\psi}{d\theta} \quad \text{(rotation away from pivot)} \quad (12a)$$

$$\frac{d\phi}{d\theta} = g'(\theta) = 1 + \frac{d\psi}{d\theta} \quad \text{(rotation toward pivot)} \quad (12b)$$

Also $\frac{d\psi}{d\theta} = \frac{dR}{d\theta}\frac{d\psi}{dR} = f'(\theta)\frac{d\psi}{dR}$ (12c)

Differentiating Eq (7)

$$\frac{d\psi}{dR} = \frac{c^2 - R^2 - l^2}{2R^2 c\sin\psi} \quad (13)$$

Finally, $d^2R/d\phi^2$ is obtained by differentiating Eq (8)

$$\frac{d^2R}{d\phi^2} = \frac{d\theta}{d\phi}\left\{\frac{[g'(\theta)][f''(\theta)] - [f'(\theta)][g''(\theta)]}{[g'(\theta)]^2}\right\} \quad (14)$$

Furthermore, since $d\theta/d\phi = 1/g'(\theta)$

$$\frac{d^2R}{d\phi^2} = \frac{[g'(\theta)][f''(\theta)] - [f'(\theta)][g''(\theta)]}{[g'(\theta)]^3} \quad (15)$$

Both $f'(\theta)$ and $g'(\theta)$ have previously been evaluated, Eqs (11), (12a) and (12b). Then

$$f''(\theta) = \frac{d^2R}{d\theta^2} = \frac{d}{d\theta}\left[\frac{lc\sin\delta\frac{d\gamma}{d\theta}}{R}\right]$$

$$= \frac{Rlc\frac{d}{d\theta}\left(\sin\delta\frac{d\gamma}{d\theta}\right) - \left(lc\sin\delta\frac{d\gamma}{d\theta}\right)\frac{dR}{d\theta}}{R^2}$$

$$= \frac{Rlc\left(\sin\delta\frac{d^2\gamma}{d\theta^2} + \frac{d\gamma}{d\theta}\cos\delta\frac{d\delta}{d\theta}\right) - \left(lc\sin\delta\frac{d\gamma}{d\theta}\frac{dR}{d\theta}\right)}{R^2} \quad (16)$$

Substituting Eqs (9), (10), and (11) into Eq (16)

$$f''(\theta) = \frac{(lc \sin \delta)\left(\frac{d^2\gamma}{d\theta^2}\right) + (lc \cos \delta)\left(\frac{d\gamma}{d\theta}\right)^2 - [f'(\theta)]^2}{R} \quad (17)$$

Differentiating Eqs (12a) and (12b)

$$g''(\theta) = -\frac{d^2\psi}{d\theta^2} \quad \text{(rotation away from pivot)} \quad (18a)$$

$$g''(\theta) = +\frac{d^2\psi}{d\theta^2} \quad \text{(rotation toward pivot)} \quad (18b)$$

Then

$$\frac{d^2\psi}{d\theta^2} = \frac{d}{d\theta}\left(\frac{d\psi}{dR}\frac{dR}{d\theta}\right) = \left(\frac{d\psi}{dR}\frac{d^2R}{d\theta^2}\right) + \left(\frac{dR}{d\theta}\right)\left(\frac{d}{d\theta}\right)\left(\frac{d\psi}{dR}\right)$$

$$= \frac{d\psi}{dR} f''(\theta) + [f'(\theta)]\left[\frac{d}{d\theta}\left(\frac{d\psi}{dR}\right)\right] \quad (19)$$

Evaluating $d/d\theta(d\psi/dR)$ from Eq (13)

$$\frac{d}{d\theta}\left(\frac{d\psi}{dR}\right) = \frac{d}{d\theta}\left(\frac{c^2 - R^2 - l^2}{2R^2 c \sin \psi}\right) =$$

$$\frac{-R^2 \sin \psi (f'(\theta)) - (c^2 - R^2 - l^2)\left(\frac{R}{2}\cos \psi \frac{d\psi}{d\theta} + \sin \psi f'(\theta)\right)}{R^3 c \sin^2 \psi} \quad (20)$$

The factor $d^2R/d\phi^2$ can now be computed and the radius of curvature can be found for a given motion curve, follower system, and direction of rotation at any point.

Specific equations for the angular motion of the follower arm for cycloidal motion are

$$\gamma = \tau\left(\frac{\theta}{\beta} - \frac{1}{2\pi}\sin 2\pi\frac{\theta}{\beta}\right)$$

$$\frac{d\gamma}{d\theta} = \frac{\tau}{\beta}\left(1 - \cos 2\pi\frac{\theta}{\beta}\right)$$

$$\frac{d^2\gamma}{d\theta^2} = \frac{2\pi\tau}{\beta^2}\left(\sin 2\pi\frac{\theta}{\beta}\right)$$

For harmonic motion

$$\gamma = \frac{\tau}{2}\left(1 - \cos \pi\frac{\theta}{\beta}\right)$$

$$\frac{d\gamma}{d\theta} = \frac{\pi\tau}{2\beta}\left(\sin \pi\frac{\theta}{\beta}\right)$$

$$\frac{d^2\gamma}{d\theta^2} = \frac{\pi^2\tau}{2\beta^2}\left(\cos \pi\frac{\theta}{\beta}\right)$$

where τ is the total angular displacement of follower arm in a complete event.

As discussed for the radial follower, these expressions can be substituted in Eq (1) and the result minimized to locate the value of θ corresponding to the minimum value of ρ. The resulting transcendental expression is virtually impossible to solve by normal methods. However, the approach has been a point-by-point calculation of values for ρ corresponding to different values of the parameters on a high-speed automatic computer. Values of ρ_{min} were picked off and plotted in Figs. 13-33.

Note that (1) the charts represent a number of solutions of the minimum radius and (2) the point at which this minimum exists is not specified. Location of the minimum is not difficult, however. When the minimum radius of curvature ρ_{min} is relatively small, it will tend to occur near the top of the cam rise; ρ_{min} can be accurately located by layout if it is desired to provide a hardened wear insert in the cam at this point.

In a few instances, no minimum exists because the radius of curvature approaches the value R_o asymptotically. This condition is indicated on the charts by a constant value $\rho_{min}/R_o = 1$.

The effect of roller rotation "away from pivot" or "toward pivot" has been accommodated by plotting two complete sets of charts.

"RISE" VS "FALL"

The previous discussions have been concerned with the "rise" portion of a cam which are usually the more critical because of inertia loading. For a "fall" portion, the minimum radius can be determined as it would for a "rise,"

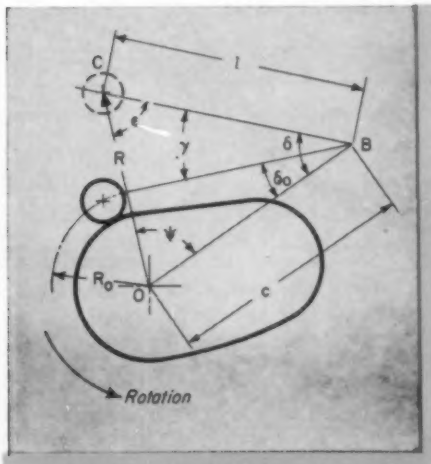


Fig. 5—Radius of curvature geometry for a swinging cam follower.

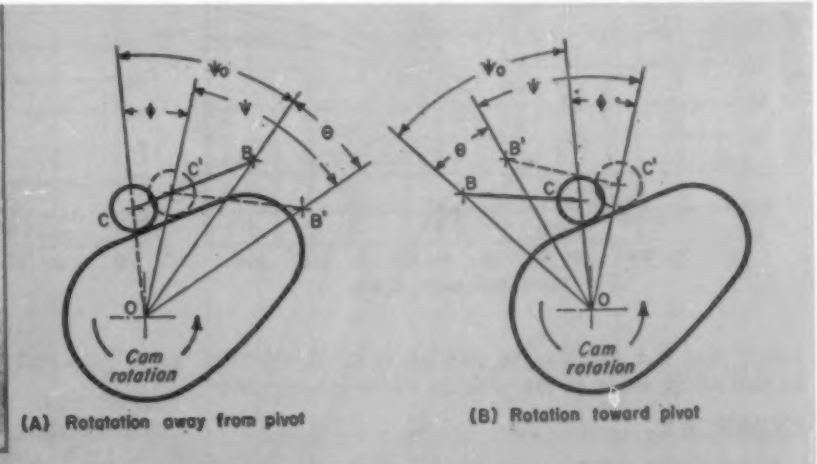
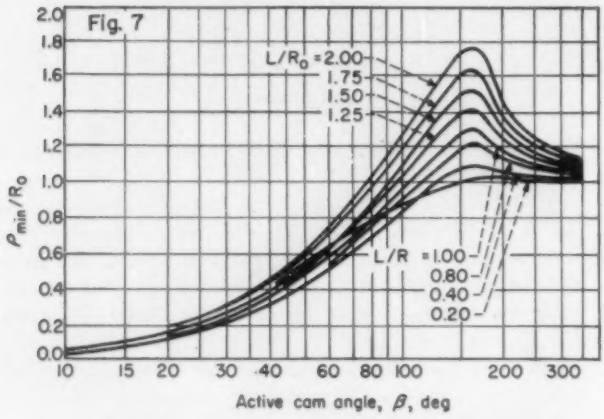


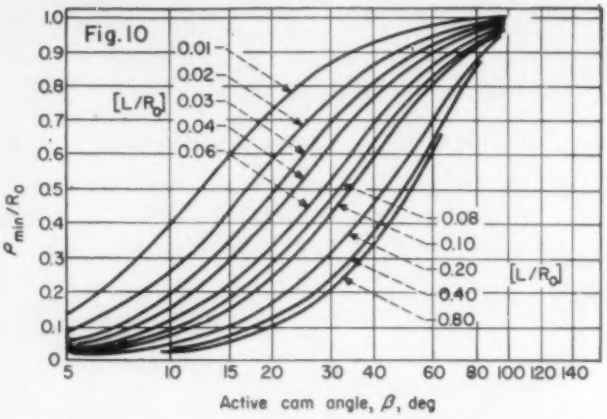
Fig. 6—Swinging follower shown with rotation "from" and "toward" pivot.

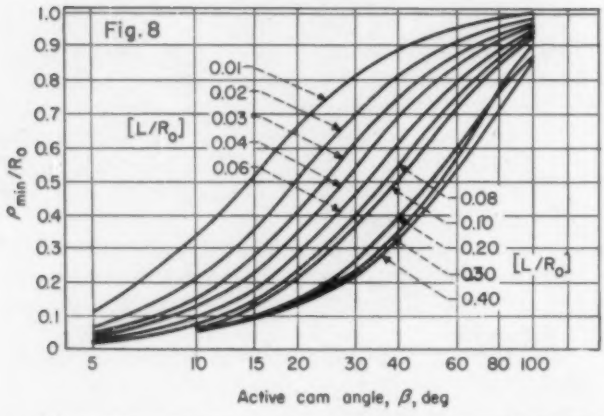
RADIAL FOLLOWER CHARTS

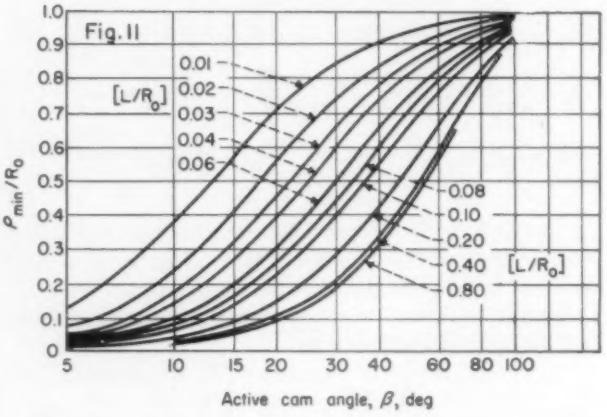
Minimum radius of curvature of the cam surface is found by subtracting the follower radius from ρ_{min}. If the difference is negative cam will be undercut.

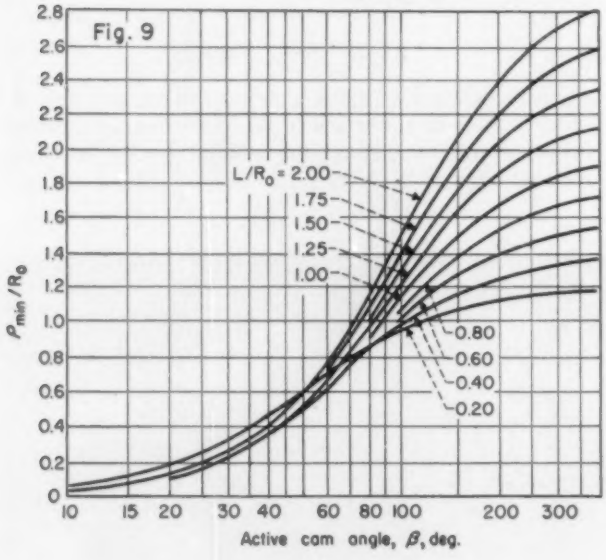
Figs. 7 and 8—Cycloidal **Figs. 9 and 10—Harmonic** **Figs. 11 and 12—Polynomial**

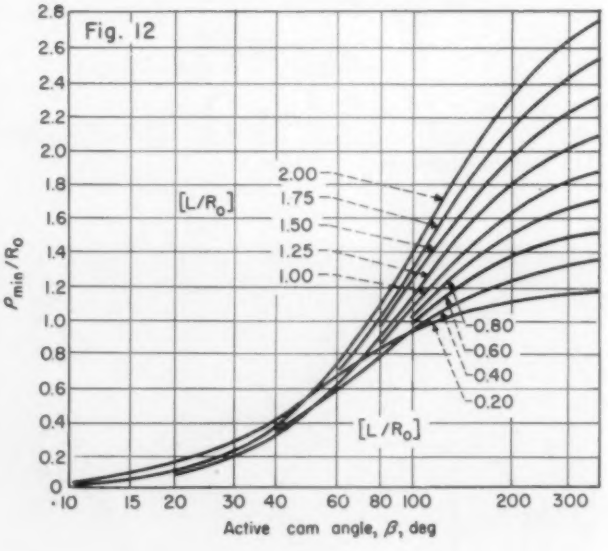












except that the direction of rotation is taken opposite to that which exists in the problem under consideration.

EXAMPLE 3

For a swinging follower mechanism similar to that of Fig. 5: $r_f = 0.375$ in., $\tau = 10$ deg, $\beta = 40$ deg, $l = 1.500$ in., and c = 2.00 in. Rotation is "away from the pivot," and cycloidal motion curve is to be used.

First solution

Assume radius to follower center at the start of the event; $R_o = 1.250$ in. Then

$$\frac{\beta}{\tau} = \frac{40}{10} = 4.0, \qquad \frac{l}{R_o} = \frac{1.500}{1.250} 1.2, \qquad \frac{c}{R_o} = \frac{2\,00}{1.25} = 1.6$$

A two-way interpolation is required to obtain ρ_{min}/R_o, as shown in Table I. Chart values are obtained from Figs. 14 and 15.

Therefore,

$$\rho_{min} = (0.41)\ (R_o) = 0.51 \text{ in.}$$
$$\rho_c = \rho_{min} - r_f = 0.51 - 0.38 = 0.13 \text{ in.}$$

This value of ρ_c should prove adequate.

In many problems a third interpolation is required when the value of τ does not correspond to one of the three charted values, 2, 10, or 30 deg. On the other hand, for many problems, particularly first approximations, it is unnecessary to interpolate and a reasonable estimate is obtained by inspection.

SLIDING TYPE FOLLOWERS. Undercutting can be a problem with sliding as well as roller followers. The analytical procedures described for roller followers can be used for a sliding-type follower with a convex surface; that is, the radius of curvature of the cam surface is obtained by subtracting the radius of the follower tip from the minimum radius of curvature of the follower center path.

TRIGONOMETRIC CORRECTION. The charts have been prepared on the basis that the angular motion of the follower arm is one of three motions, cycloidal, harmonic, or polynomial. In certain instances the follower arm drives additional linkages and parts, and cycloidal (or harmonic, etc.) motion may be required in these parts, not in the follower arm.

As will be discussed in a subsequent article of this series, suitable corrections can be incorporated by trigonometric methods, preferably with the help of automatic computing equipment. Experience has shown, however, that these corrections have a minor effect in the determination of minimum radius of curvature. They can be ignored without serious effect when time will not permit a more rigorous approach.

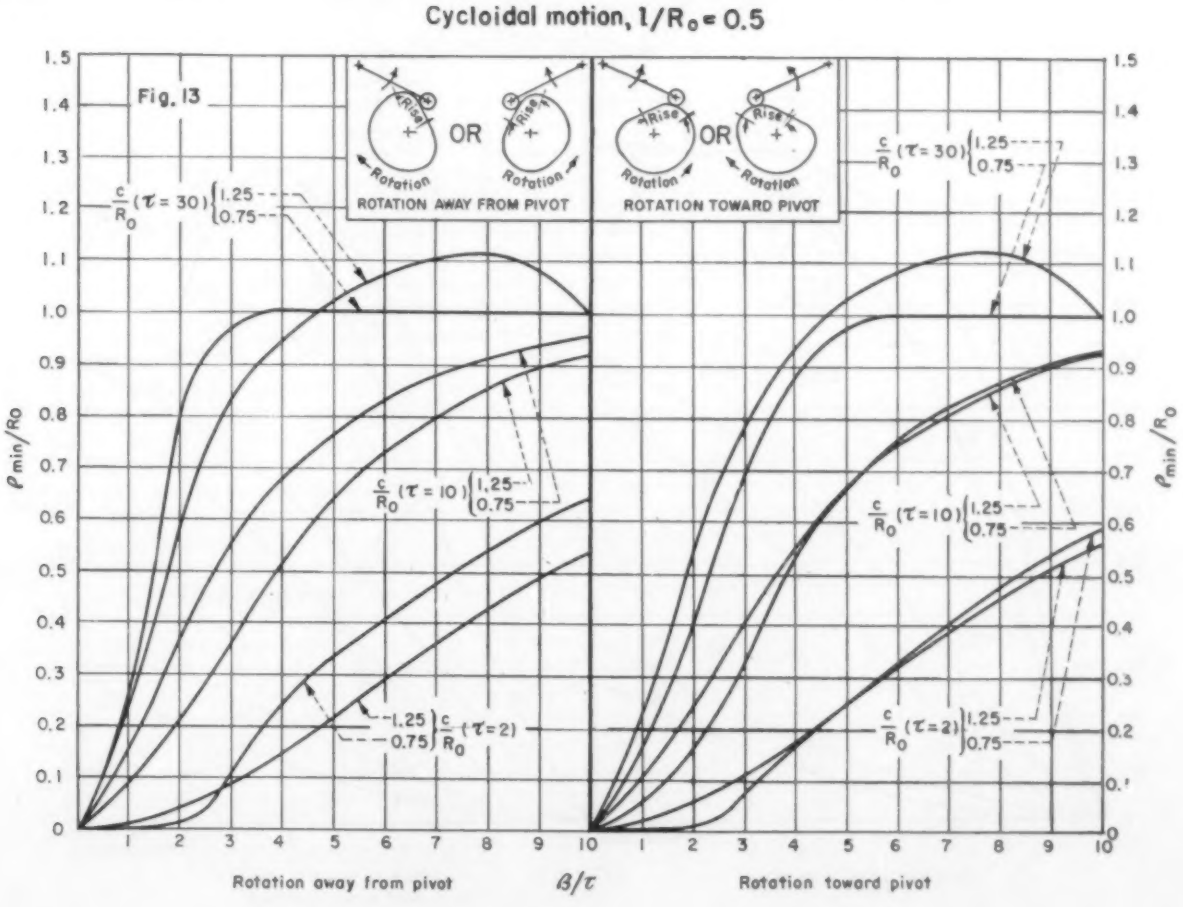
Table I—Interpolation for Example 3

FROM CHART			INTERPOLATION	
$\frac{1}{R_o}$	$\frac{c}{R_o}$	$\frac{\rho_{min}}{R_o}$	First $\left(\frac{c}{R_o}\right)$	Second $\left(\frac{1}{R_o}\right)$
1.0	1.0	0.35		
	1.6		0.49*	
1.0	1.75	0.53		
1.2				0.41
1.5	1.5	0.28		
	1.6		0.30	
1.5	2.25	0.44		

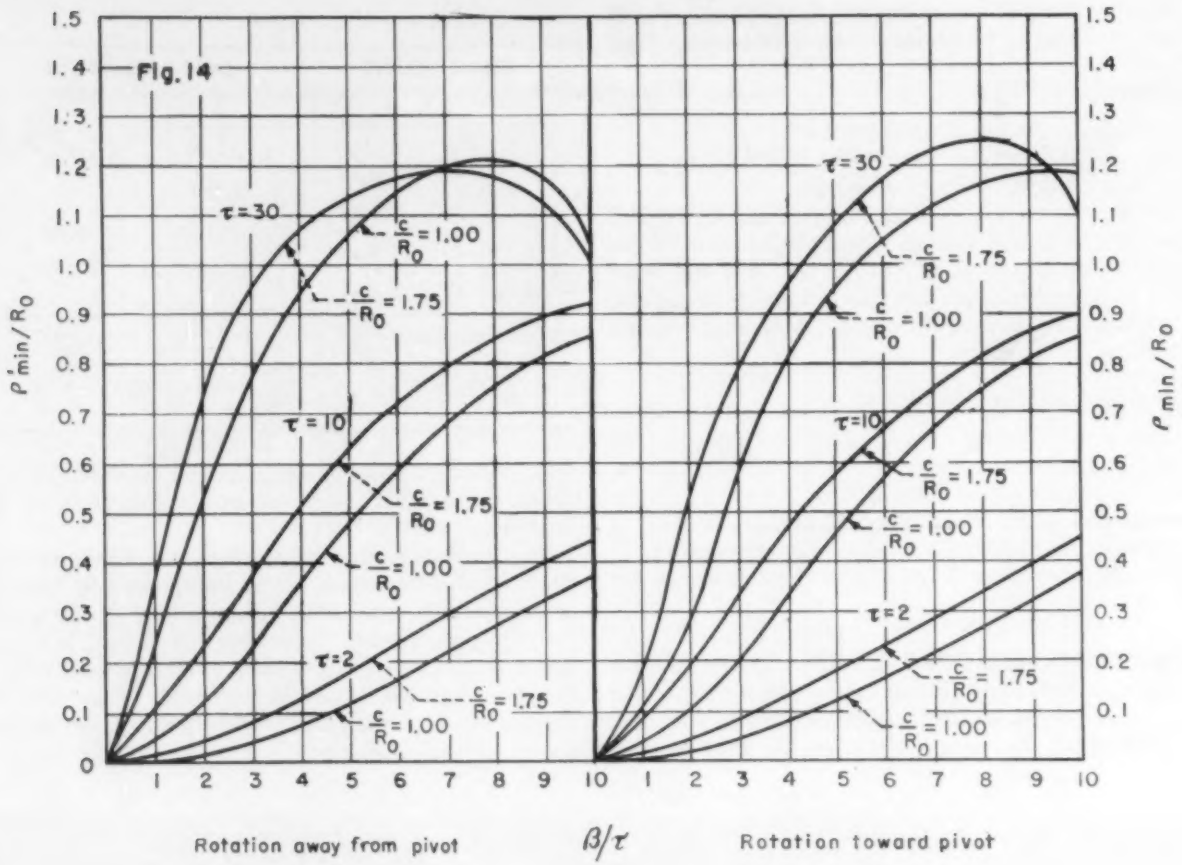
* Sample interpolation

$$\frac{\rho_{min}}{R_o} = 0.35 + \left[\frac{1.6 - 1.00}{1.75 - 1.00}\right](0.52 - 0.35) - 0.49$$

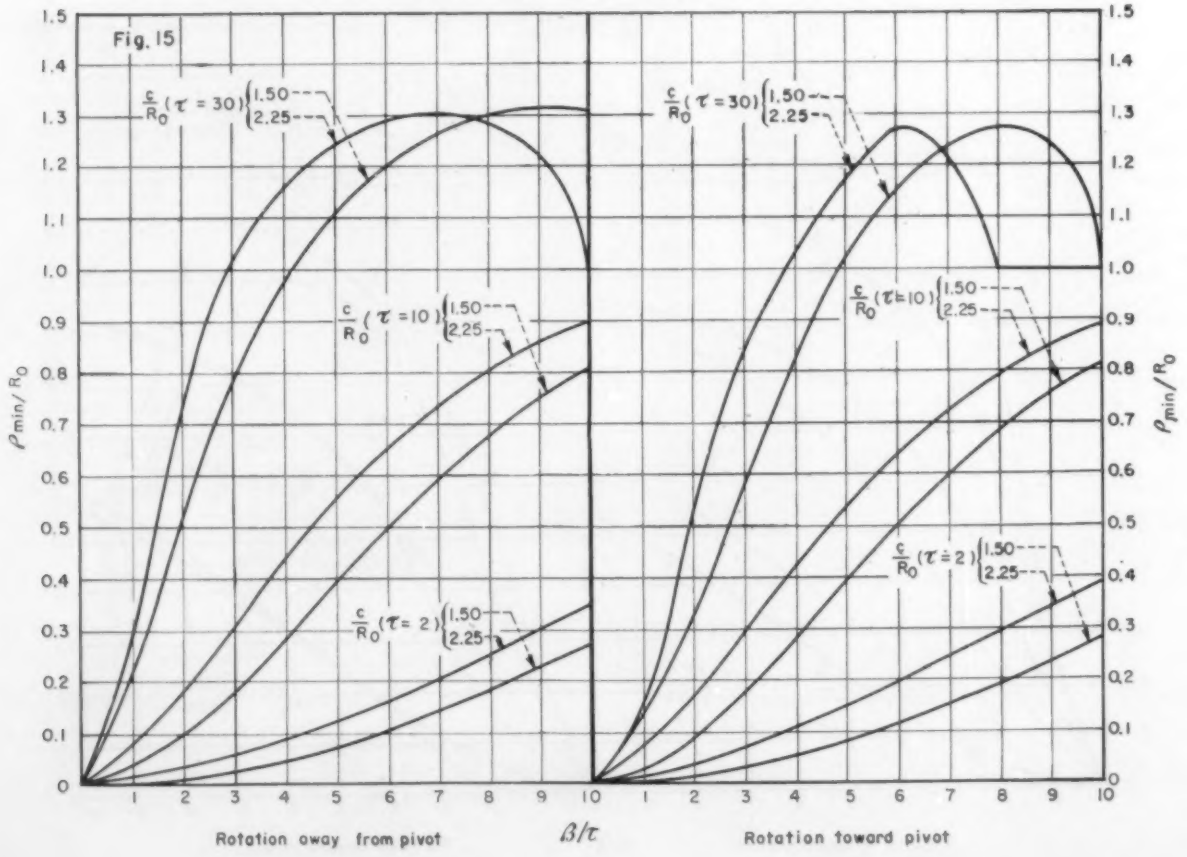
SWINGING FOLLOWER CHARTS



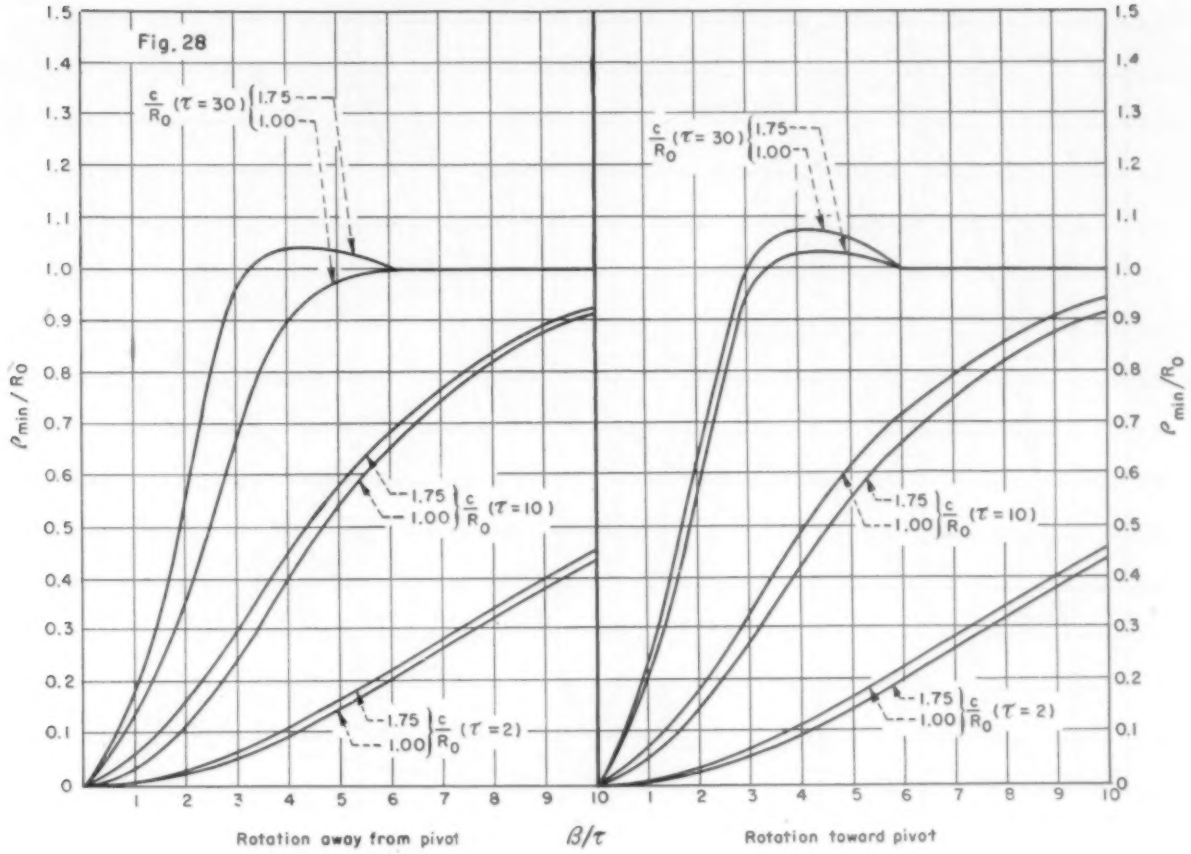
Cycloidal motion, $l/R_0 = 1.0$



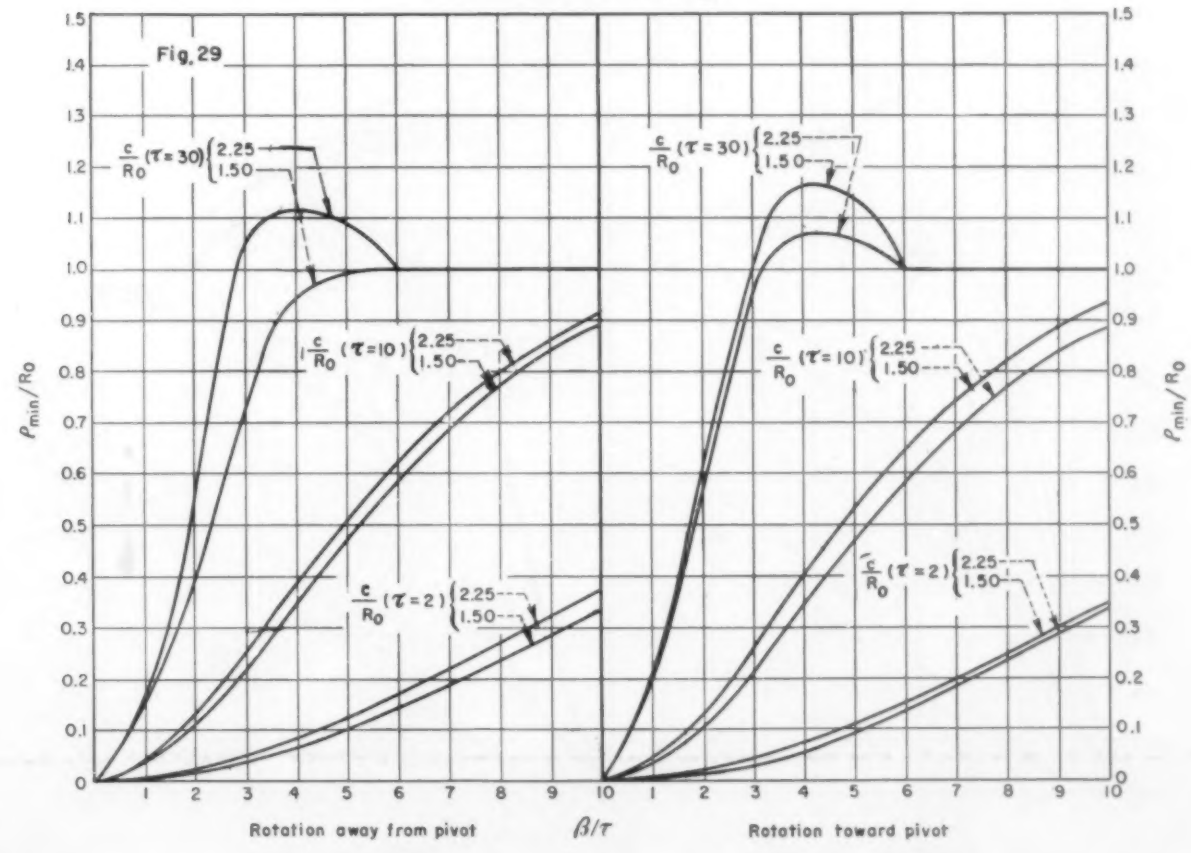
Cycloidal motion, $l/R_0 = 1.5$



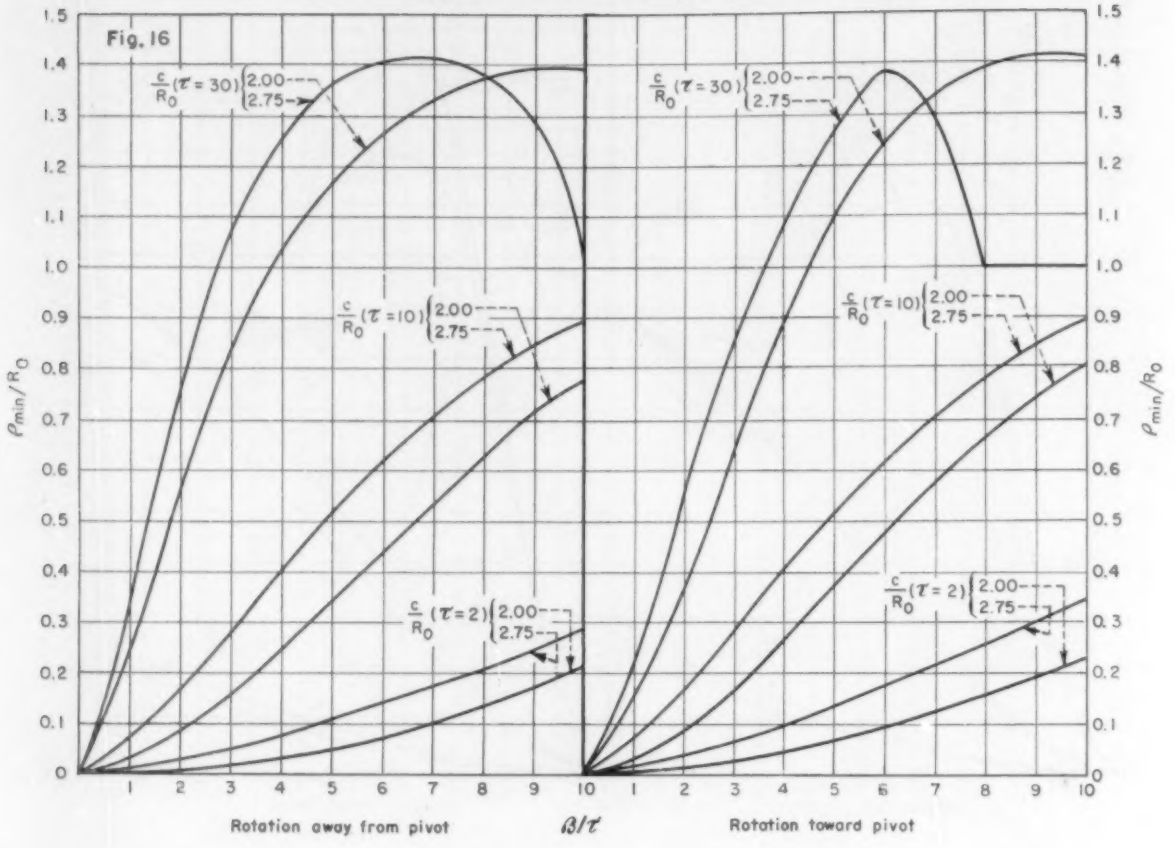
Polynomial motion, $l/R_0 = 1.0$



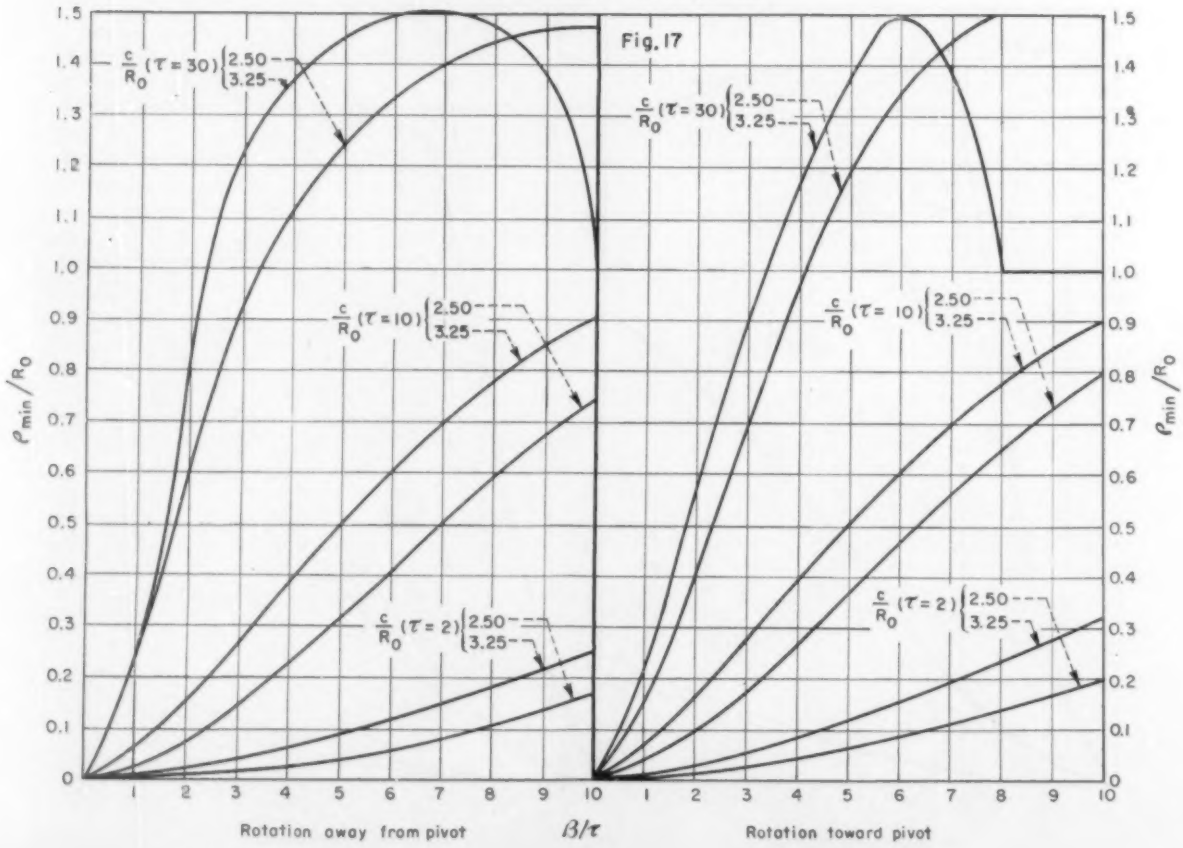
Polynomial motion, $l/R_0 = 1.5$



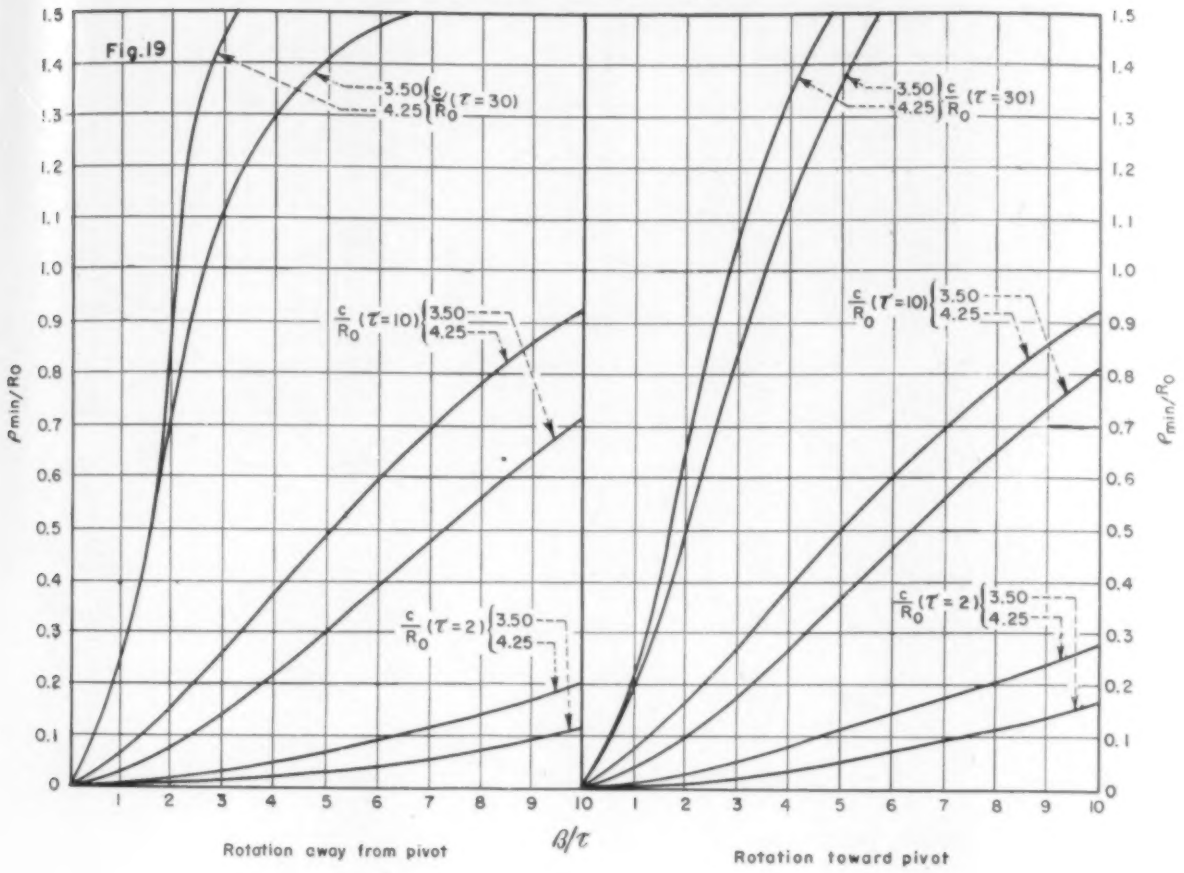
Cycloidal motion, $l/R_0 = 2.0$



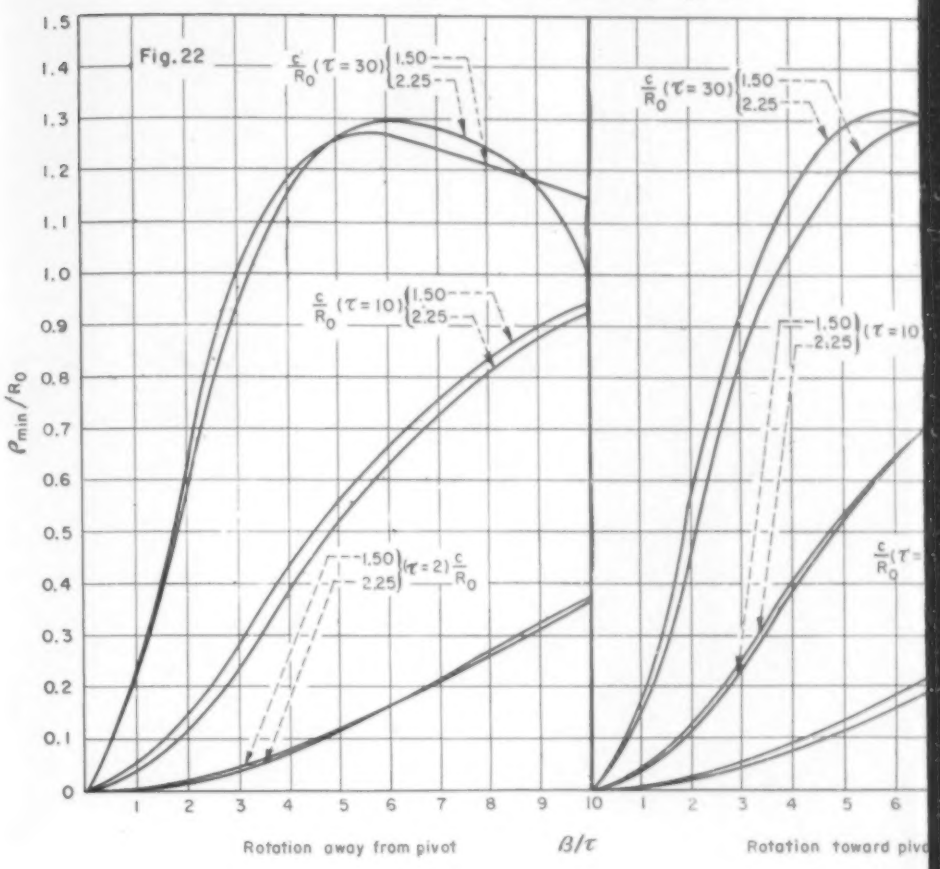
Cycloidal motion, $l/R_0 = 2.5$



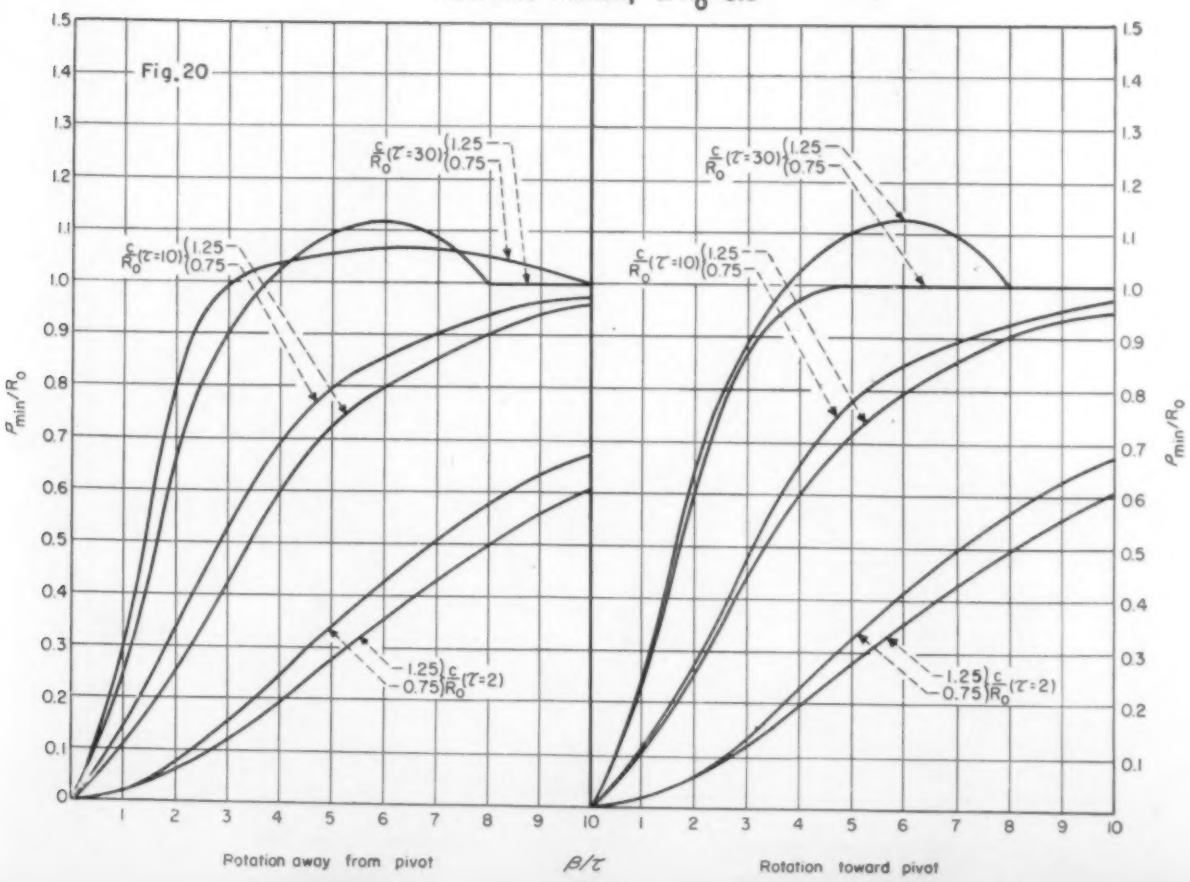
Cycloidal motion, $l/R_0 = 3.5$



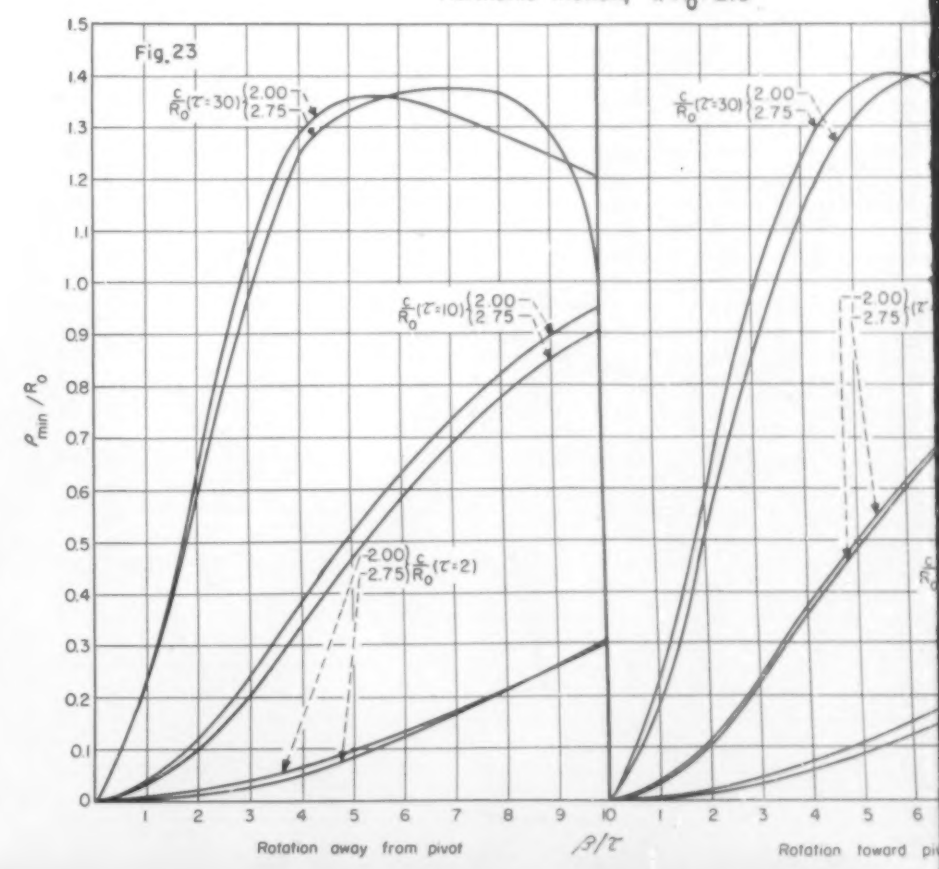
Harmonic motion, $l/R_0 = 1.5$



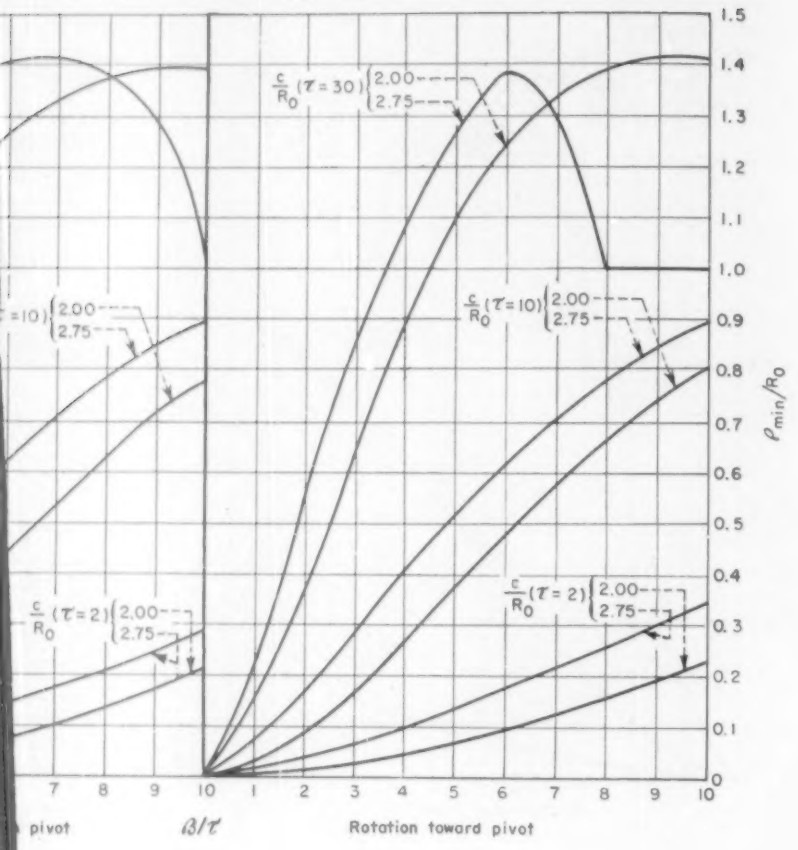
Harmonic motion, $l/R_0 = 0.5$



Harmonic motion, $l/R_0 = 2.0$

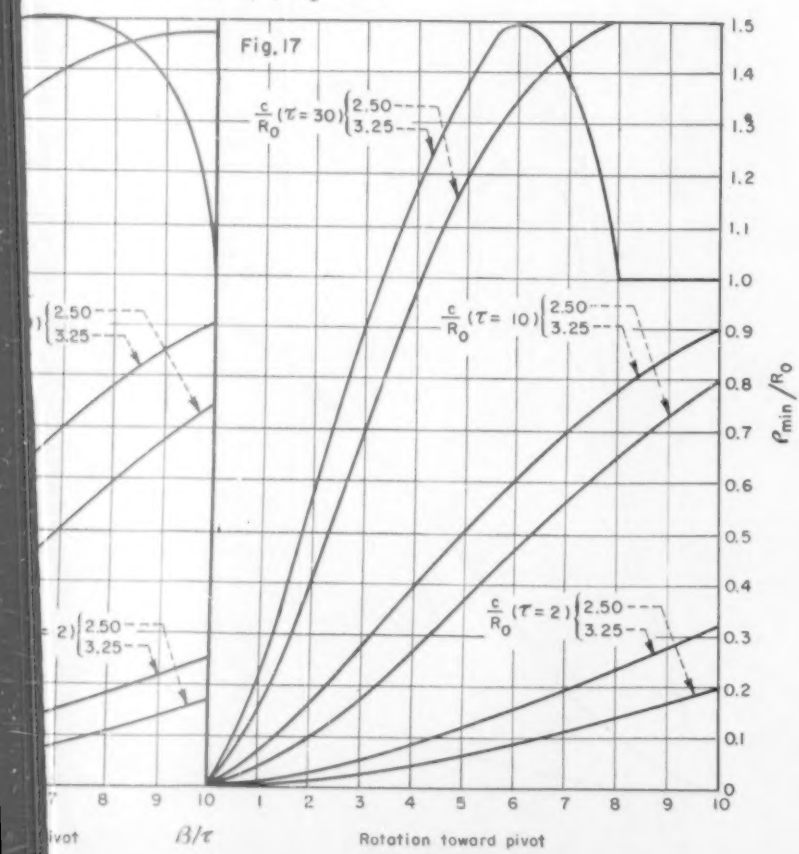


Cycloidal motion, $l/R_0 = 2.0$

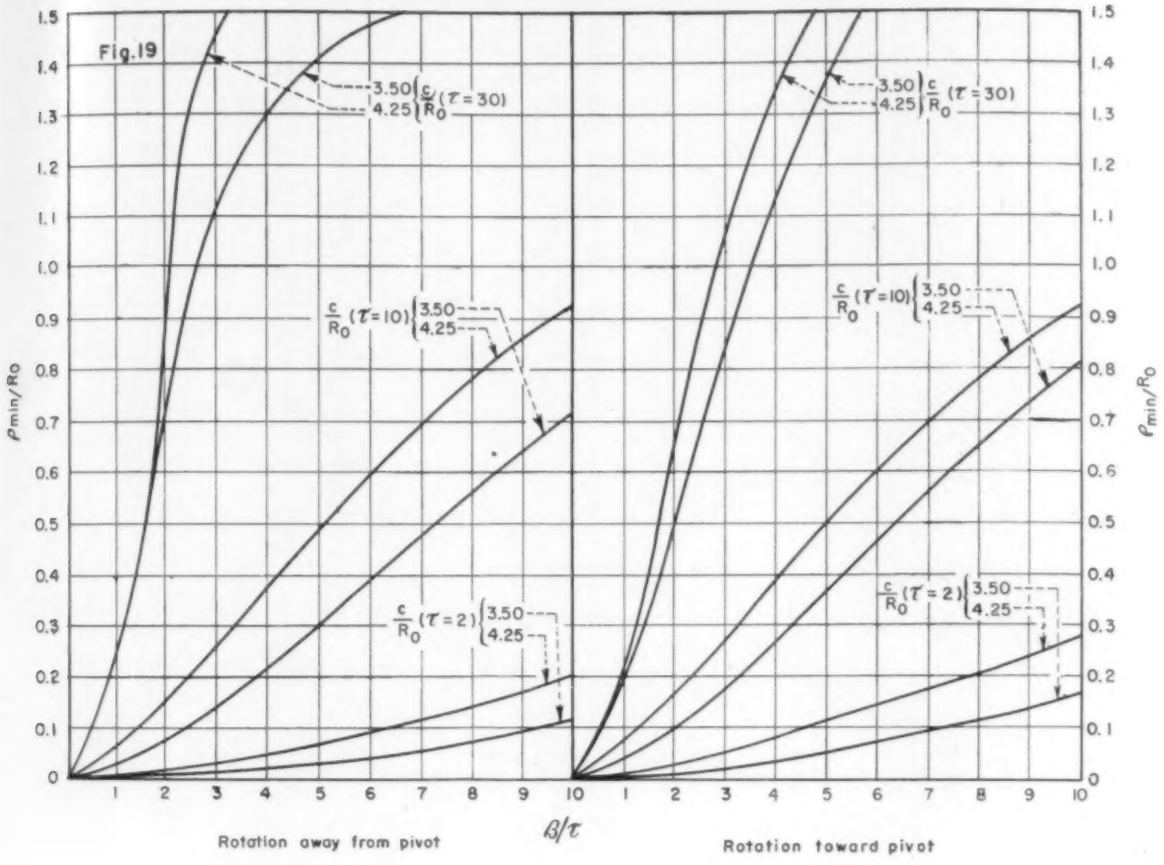


Cycloidal motion, $l/R_0 = 2.5$

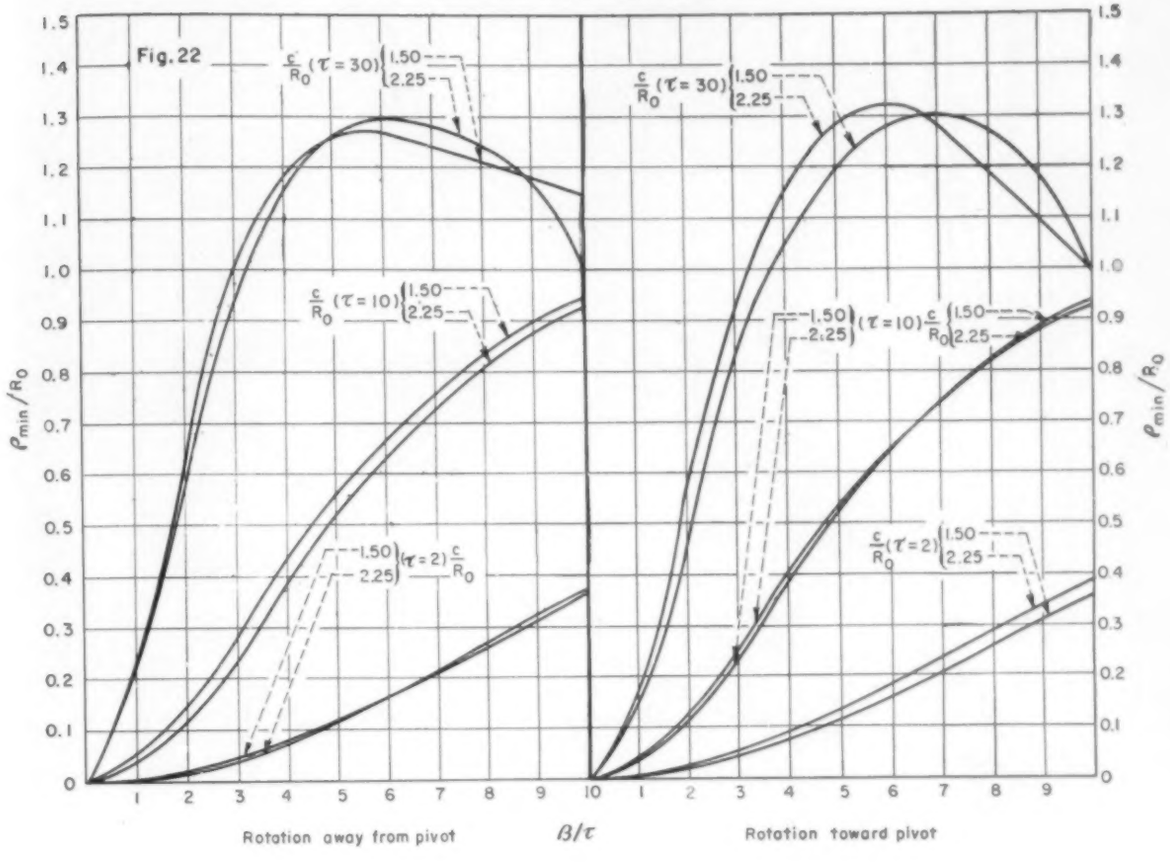
Fig. 17



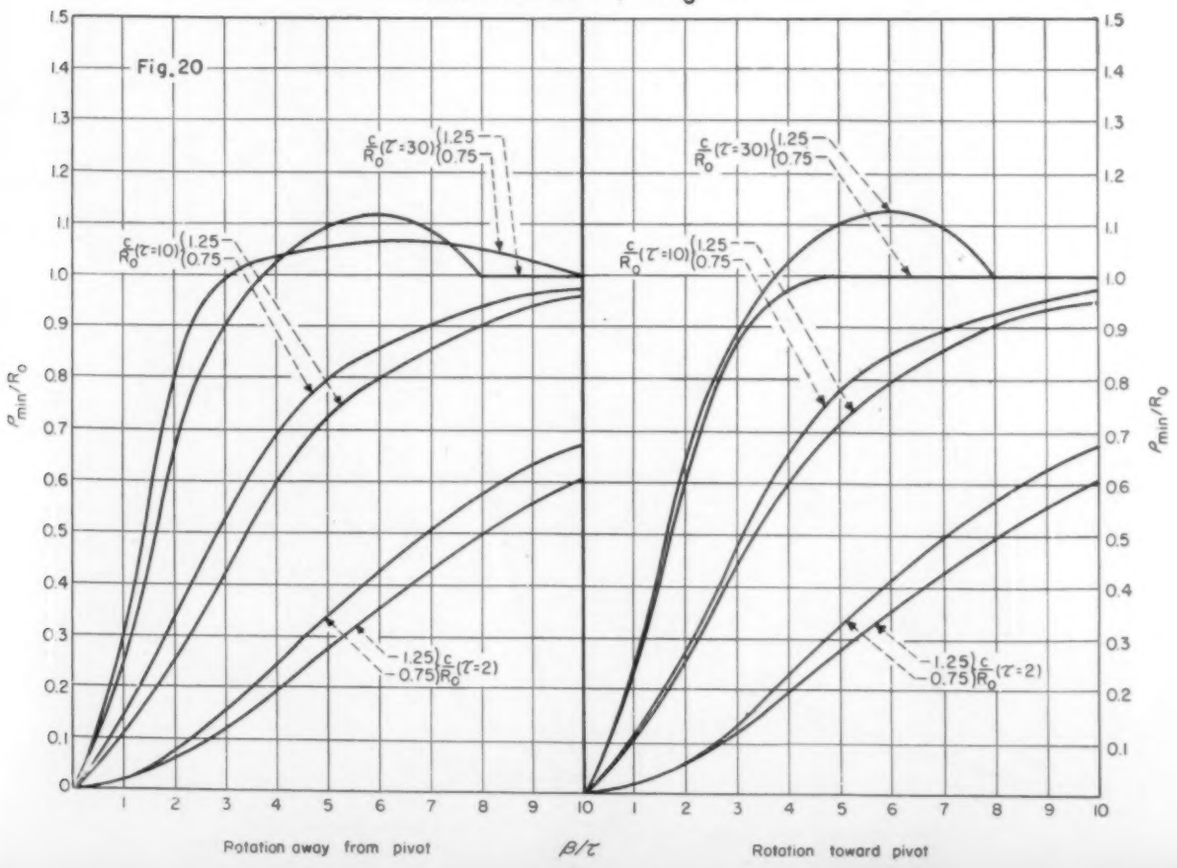
Cycloidal motion, $l/R_0 = 3.5$



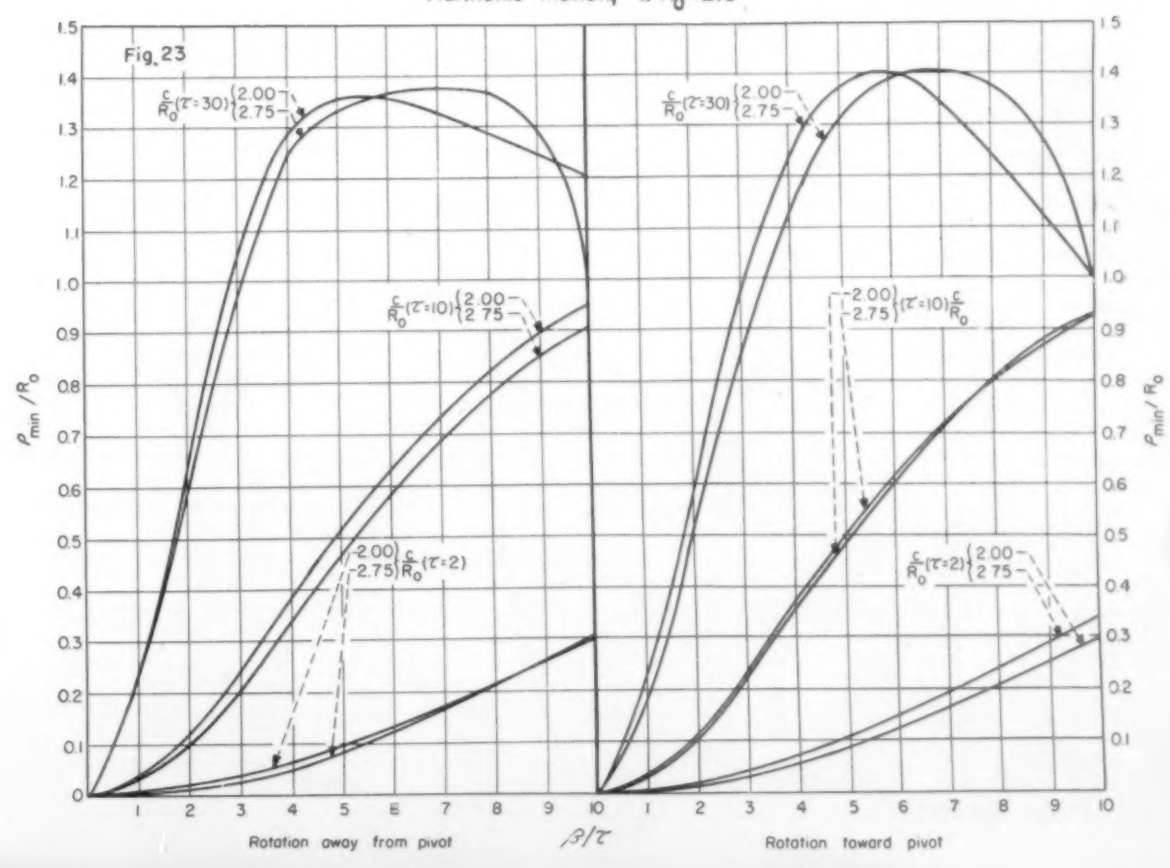
Harmonic motion, $l/R_0 = 1.5$

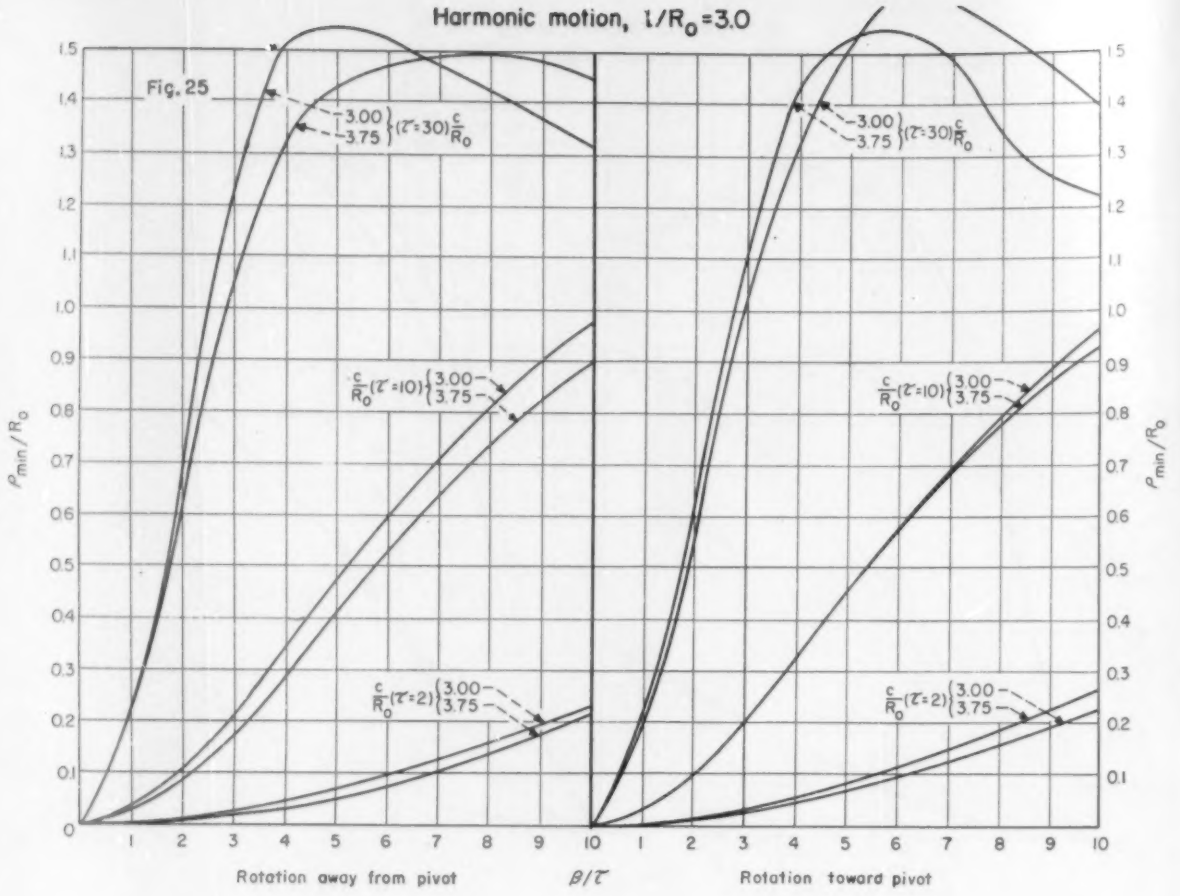


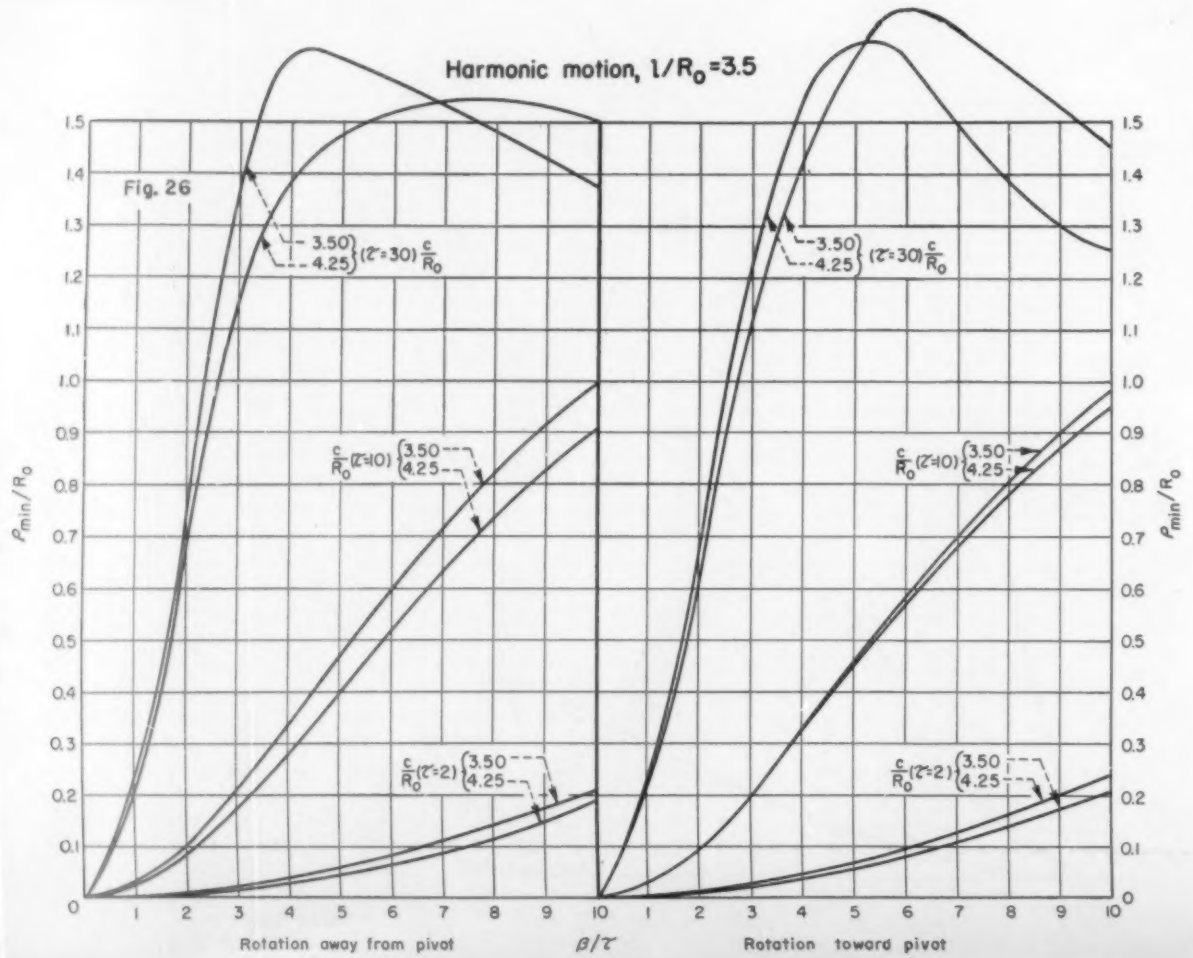
Harmonic motion, $l/R_0 = 0.5$



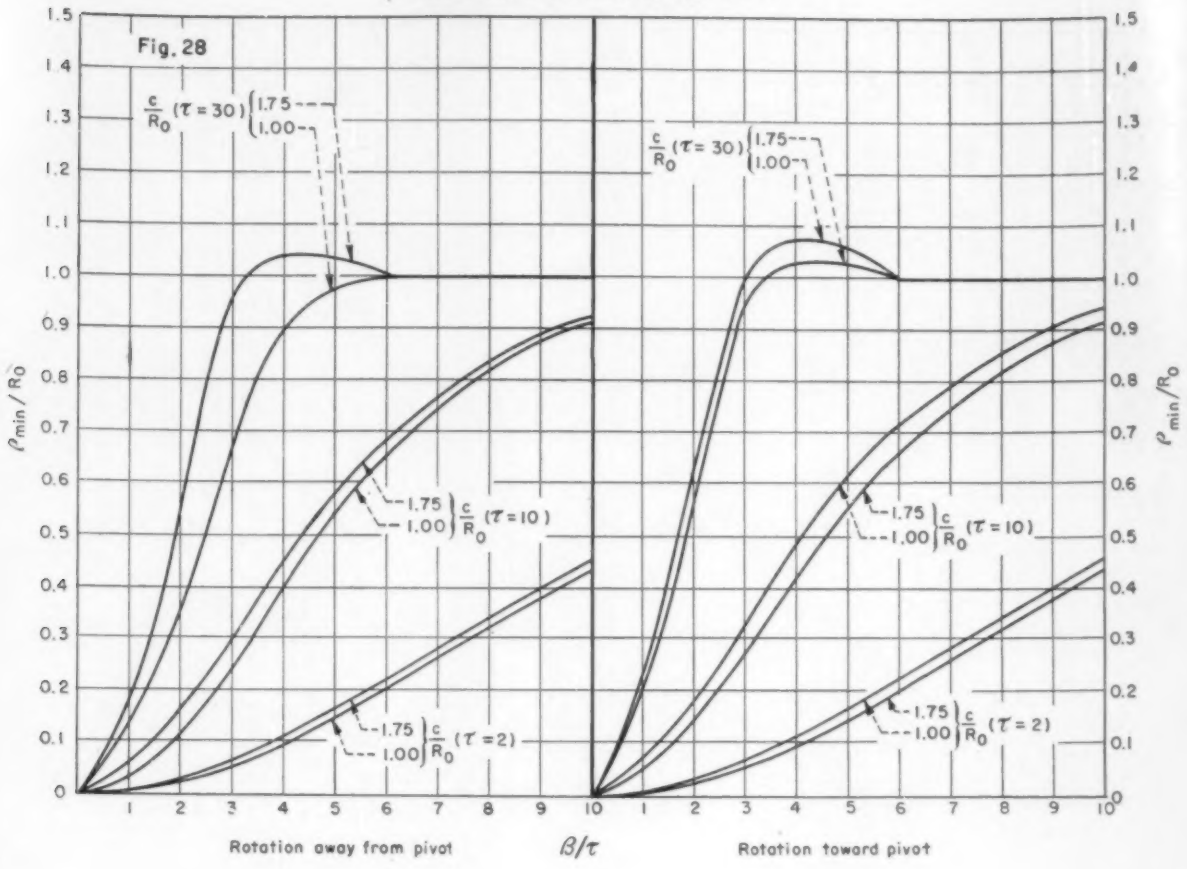
Harmonic motion, $l/R_0 = 2.0$



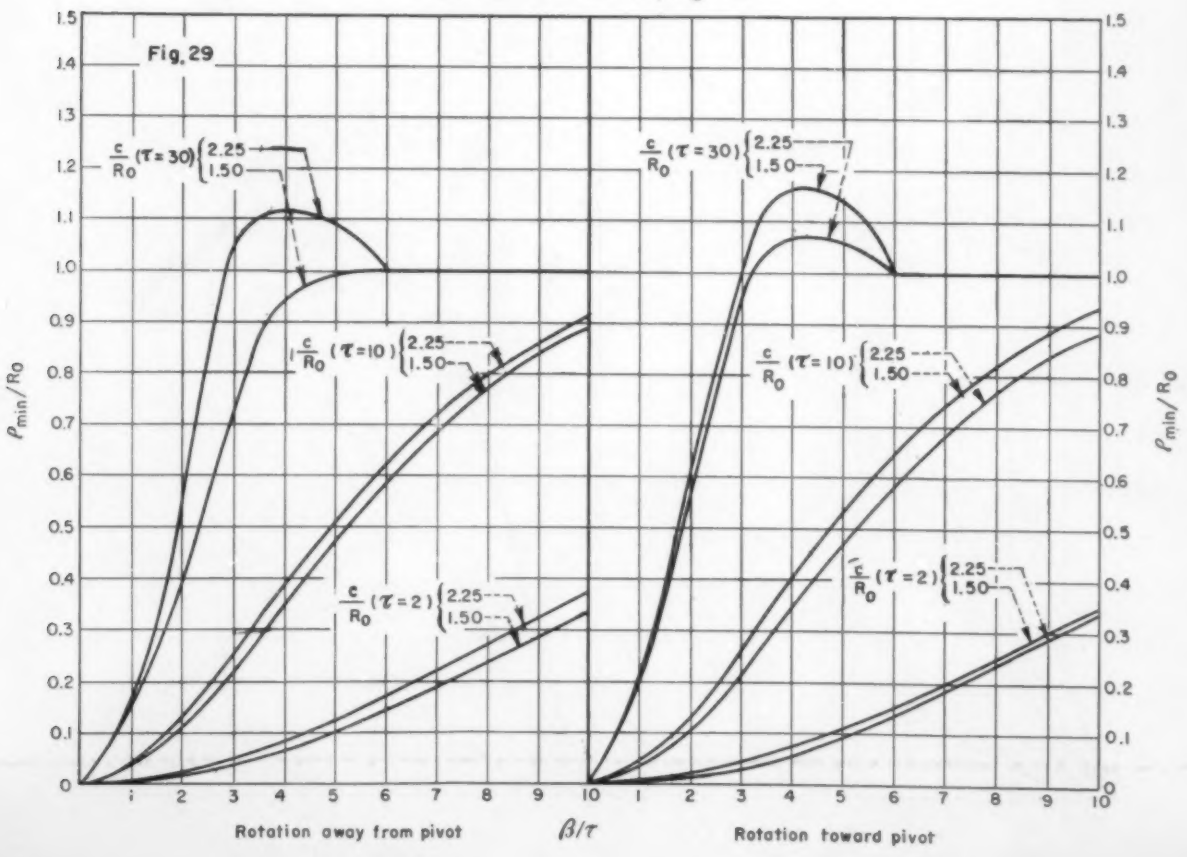

Harmonic motion, $l/R_0=3.0$
Fig. 25
3.00
3.75
$(\tau=30)\frac{c}{R_0}$
$\frac{c}{R_0}(\tau=10)$
$\frac{c}{R_0}(\tau=2)$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot


Harmonic motion, $l/R_0=3.5$
Fig. 26
3.50
4.25
$(\tau=30)\frac{c}{R_0}$
$\frac{c}{R_0}(\tau=10)$
$\frac{c}{R_0}(\tau=2)$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot

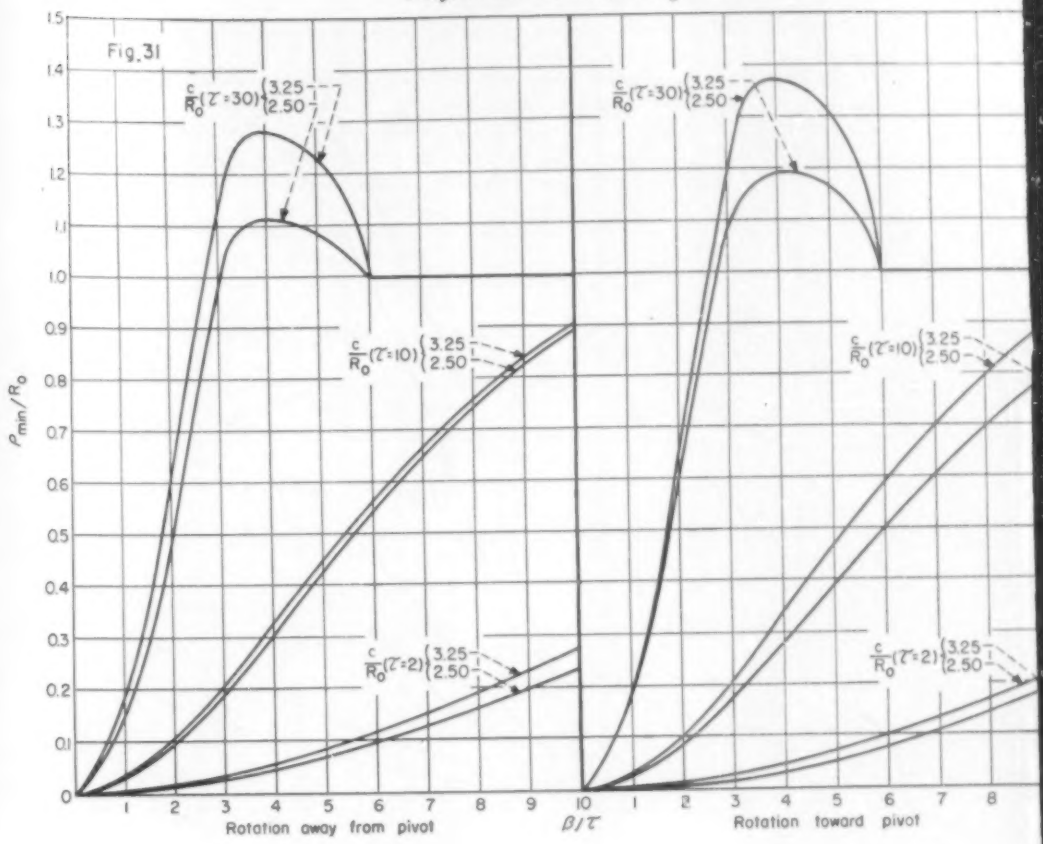
Polynomial motion, $1/R_0 = 1.0$



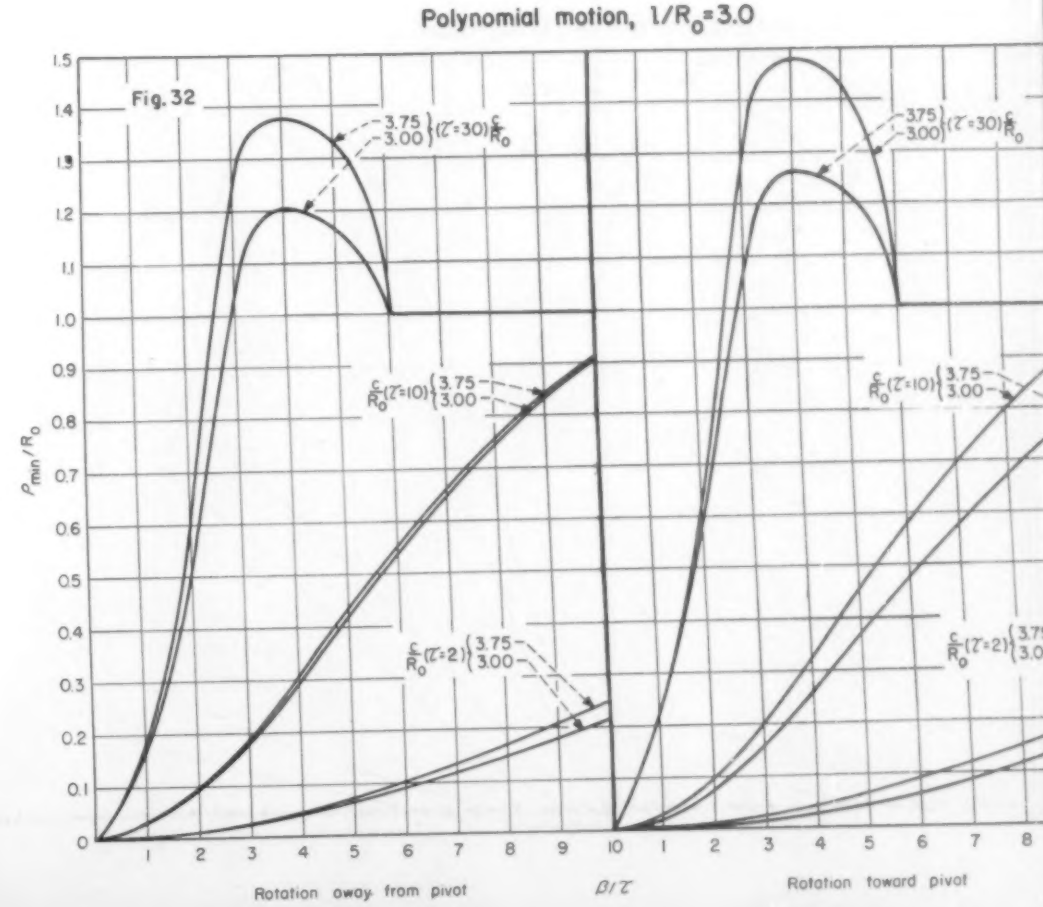
Polynomial motion, $1/R_0 = 1.5$

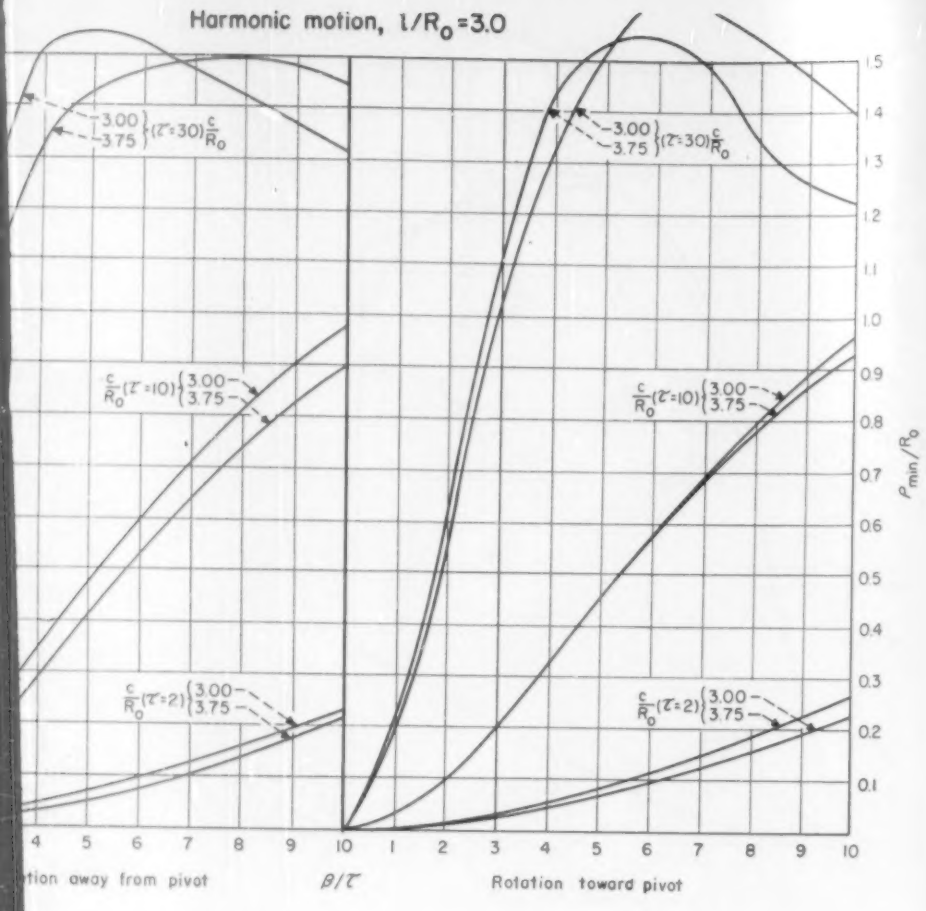


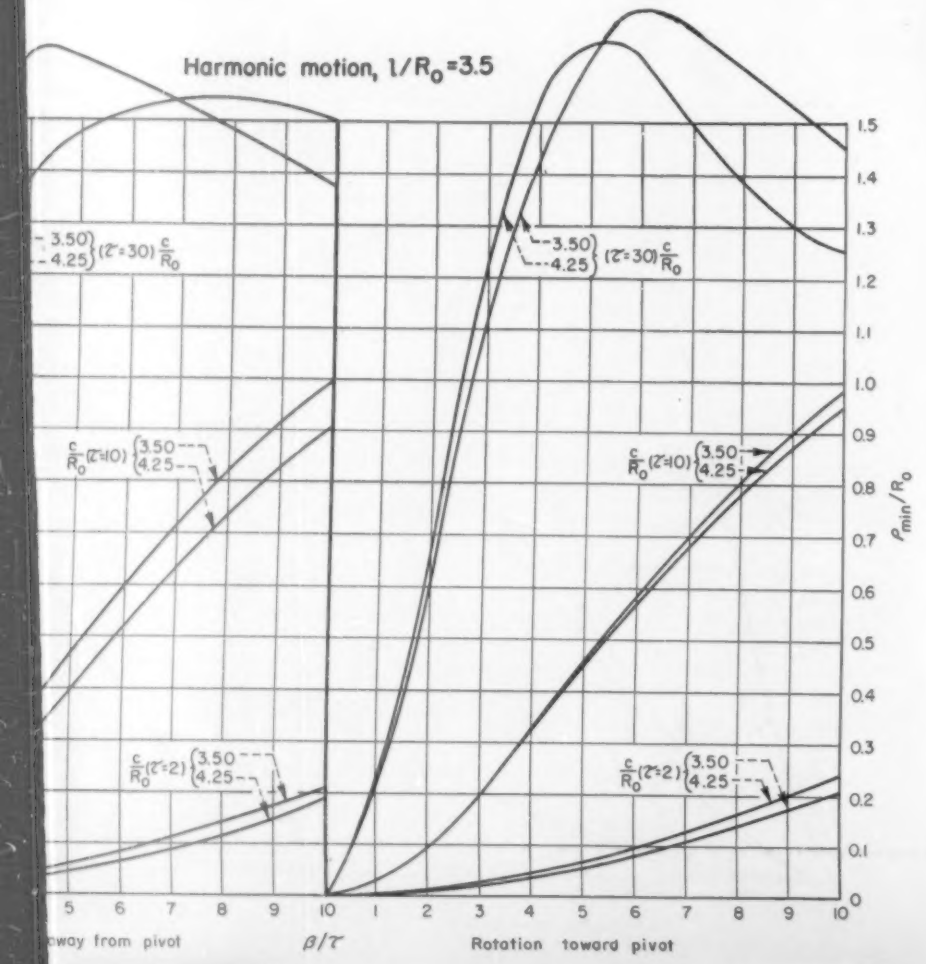
Polynomial motion, $1/R_0 = 2.5$



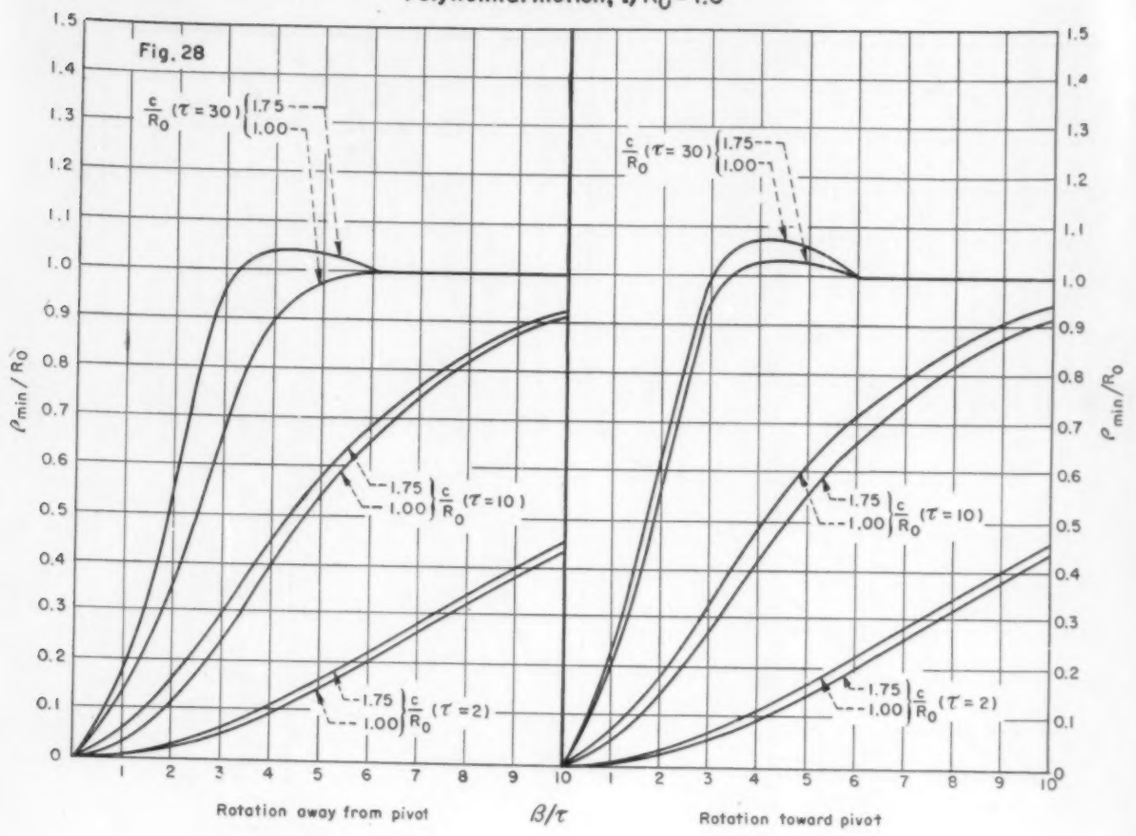
Polynomial motion, $1/R_0 = 3.0$



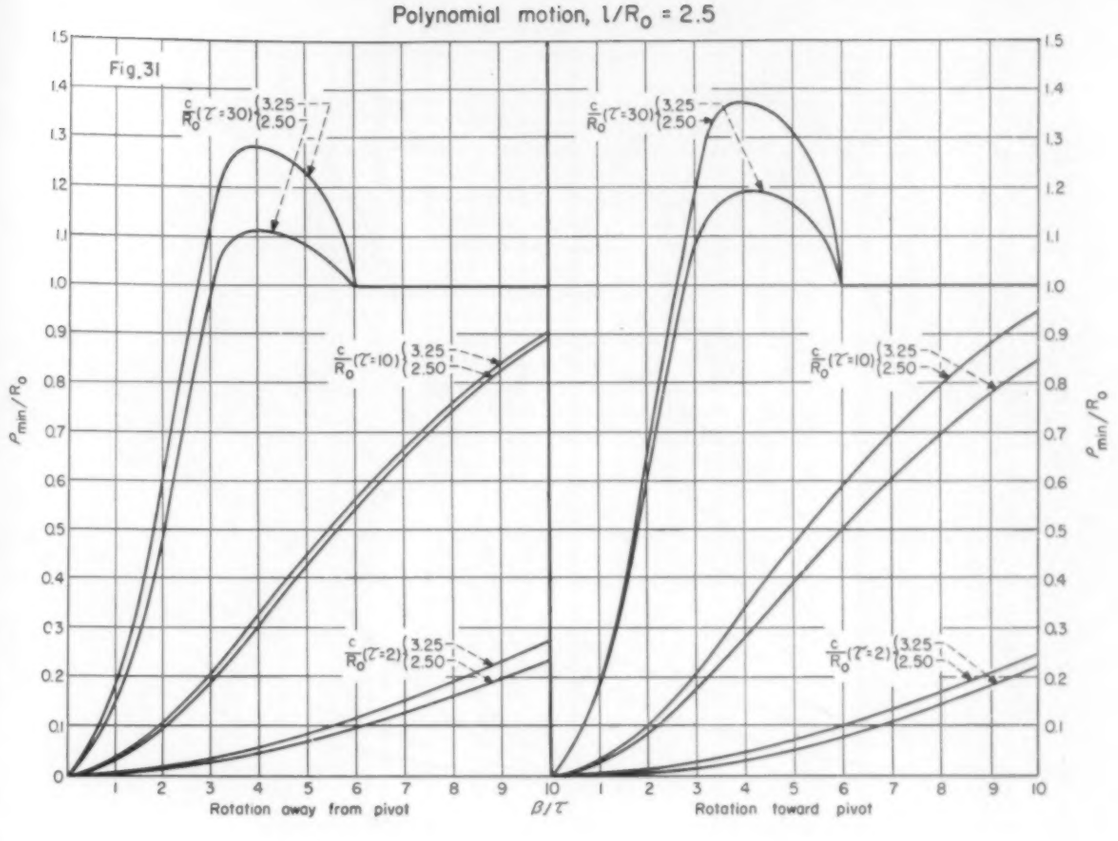

Harmonic motion, l/R0=3.0
3.00
3.75
(τ=30) c/R0
c/R0 (τ=10) 3.00 3.75
c/R0 (τ=2) 3.00 3.75
ρmin/R0
β/τ
Rotation toward pivot


Harmonic motion, l/R0=3.5
3.50
4.25
(τ=30) c/R0
c/R0 (τ=10) 3.50 4.25
c/R0 (τ=2) 3.50 4.25
ρmin/R0
β/τ
Rotation toward pivot

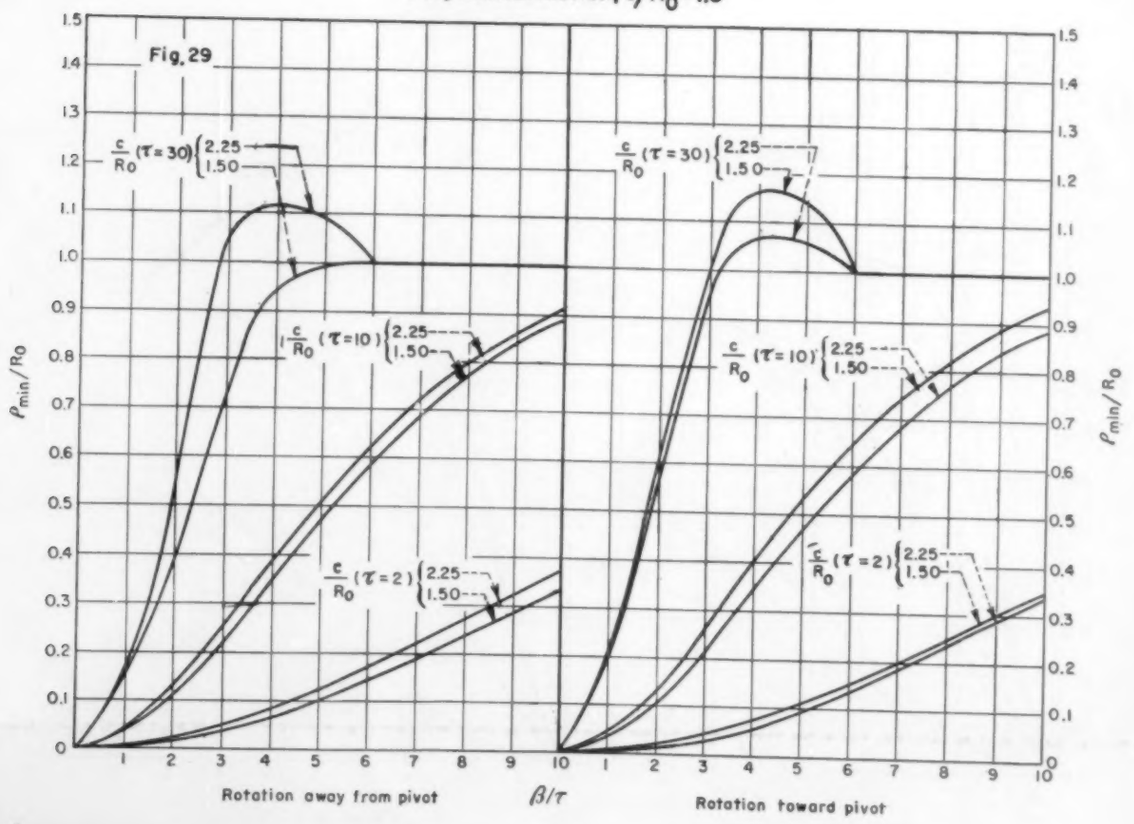
Polynomial motion, $l/R_0 = 1.0$



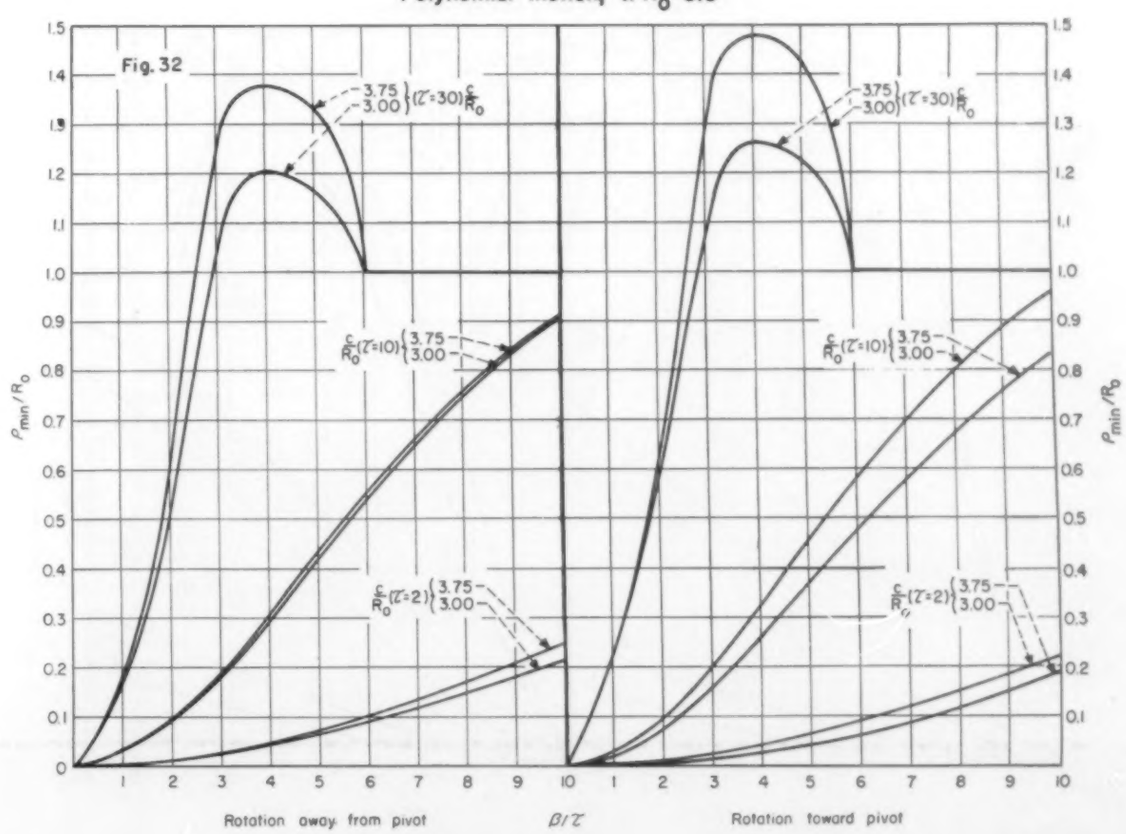
Polynomial motion, $l/R_0 = 2.5$

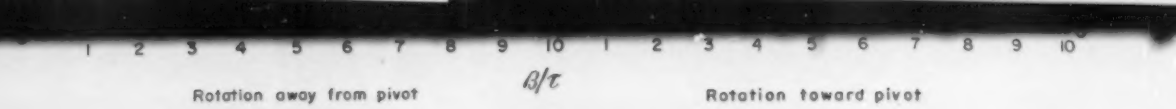


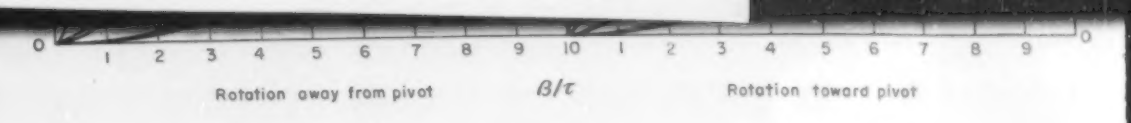
Polynomial motion, $l/R_0 = 1.5$



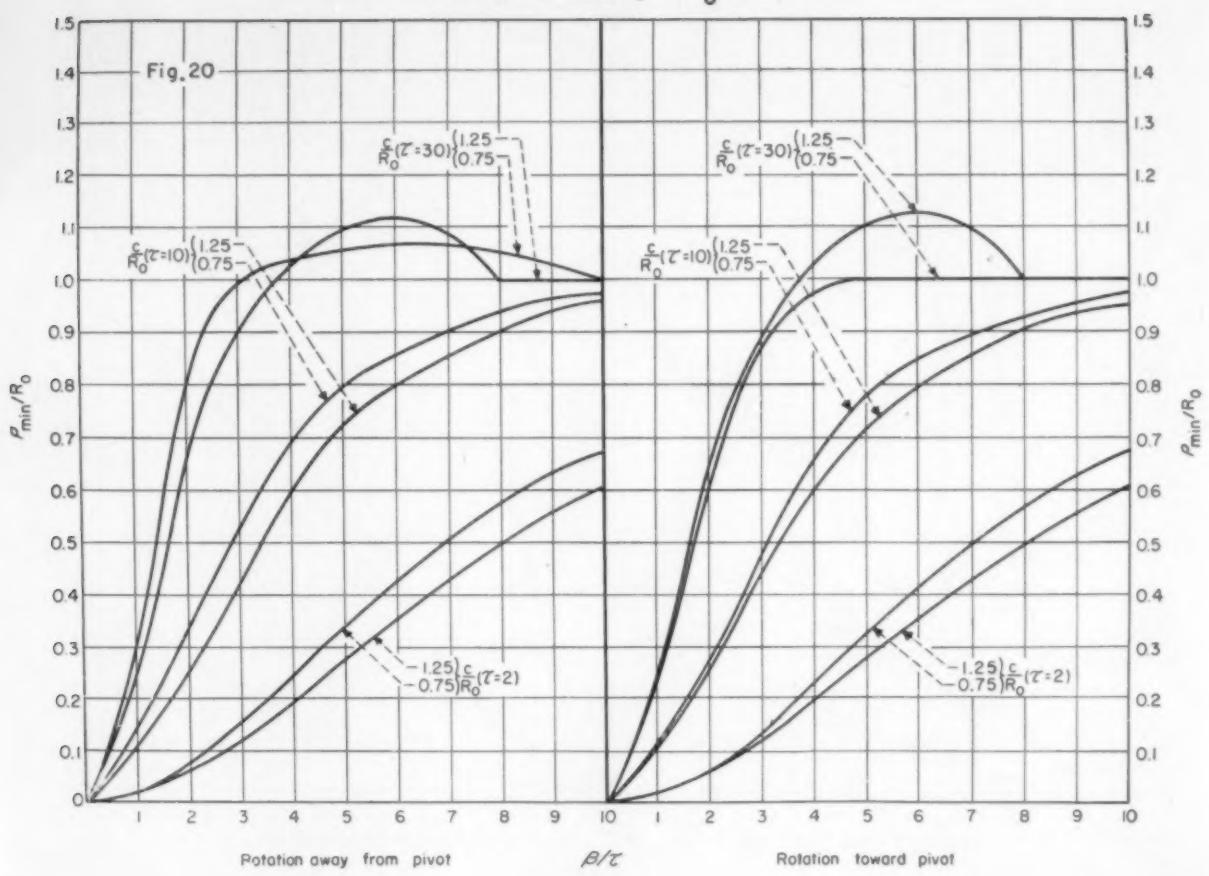
Polynomial motion, $l/R_0 = 3.0$



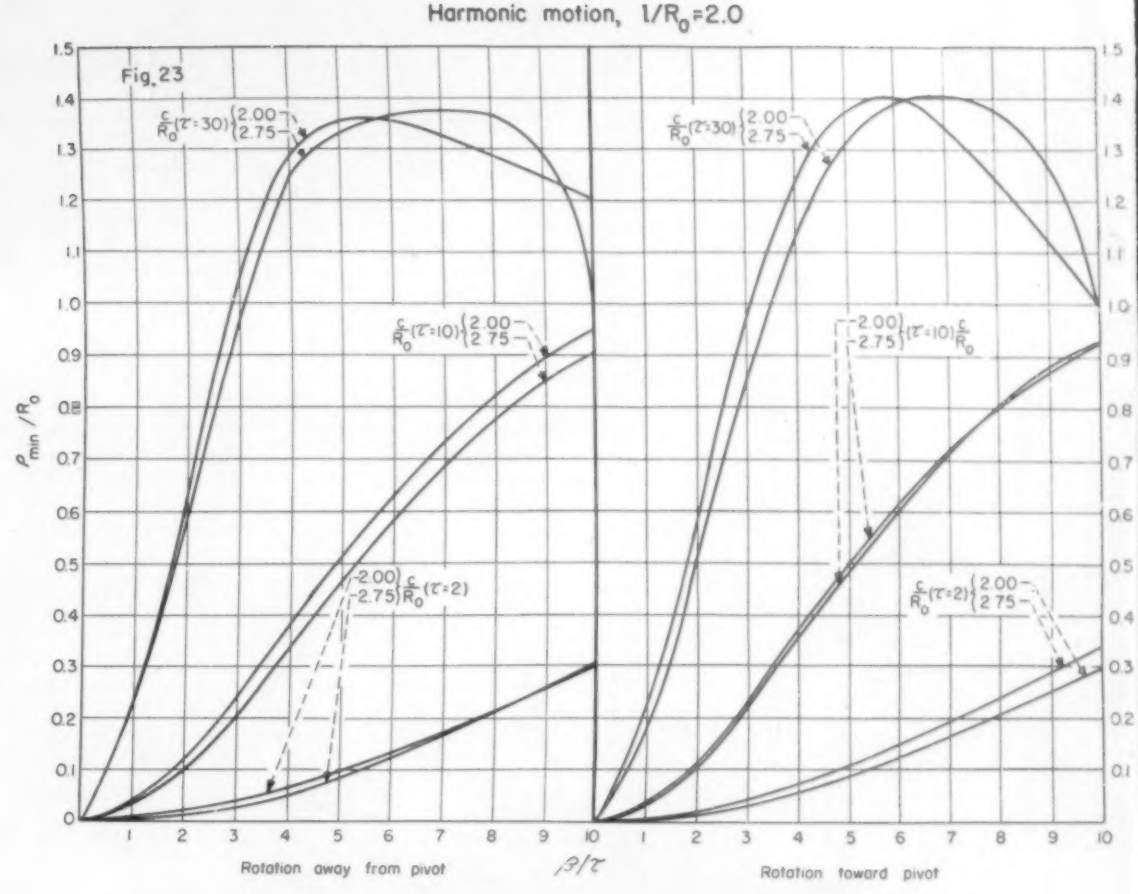




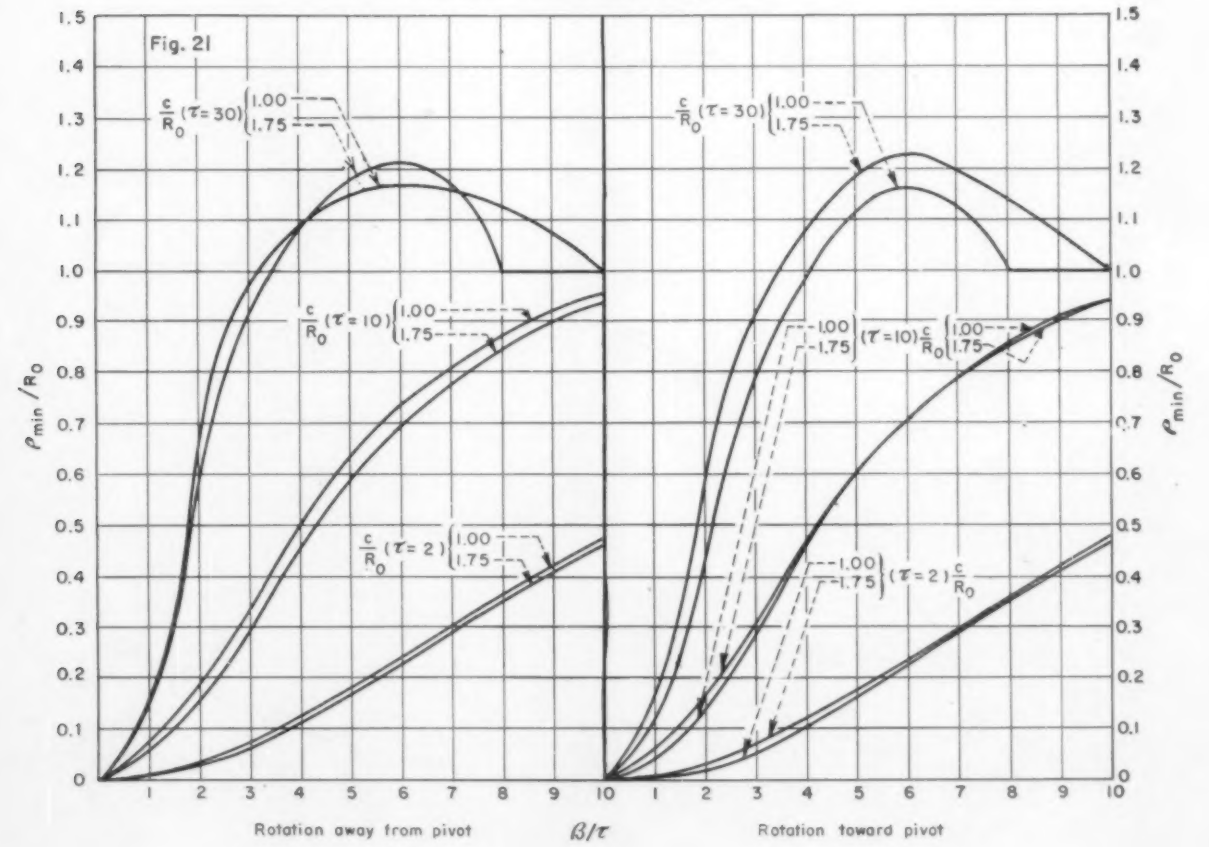
Harmonic motion, $1/R_0 = 0.5$



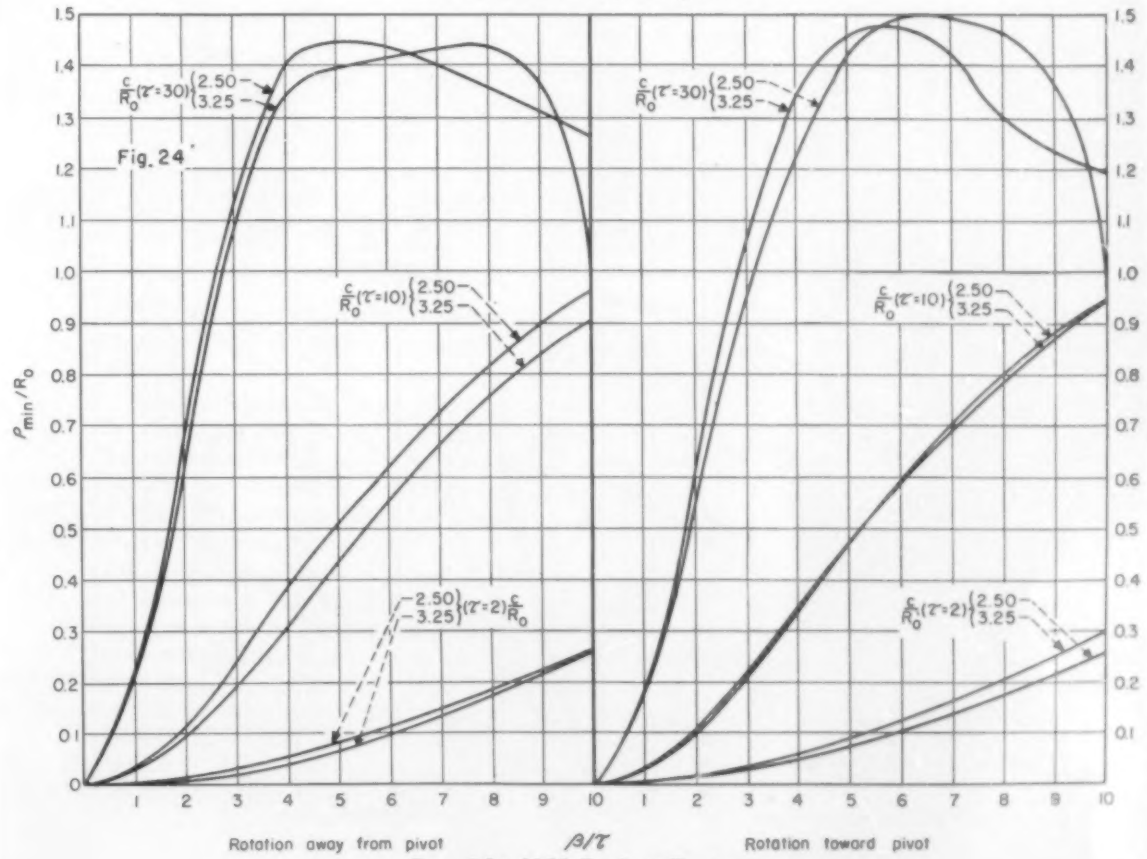
Harmonic motion, $1/R_0 = 2.0$



Harmonic motion, $1/R_0 = 1.0$



Harmonic motion, $1/R_0 = 2.5$



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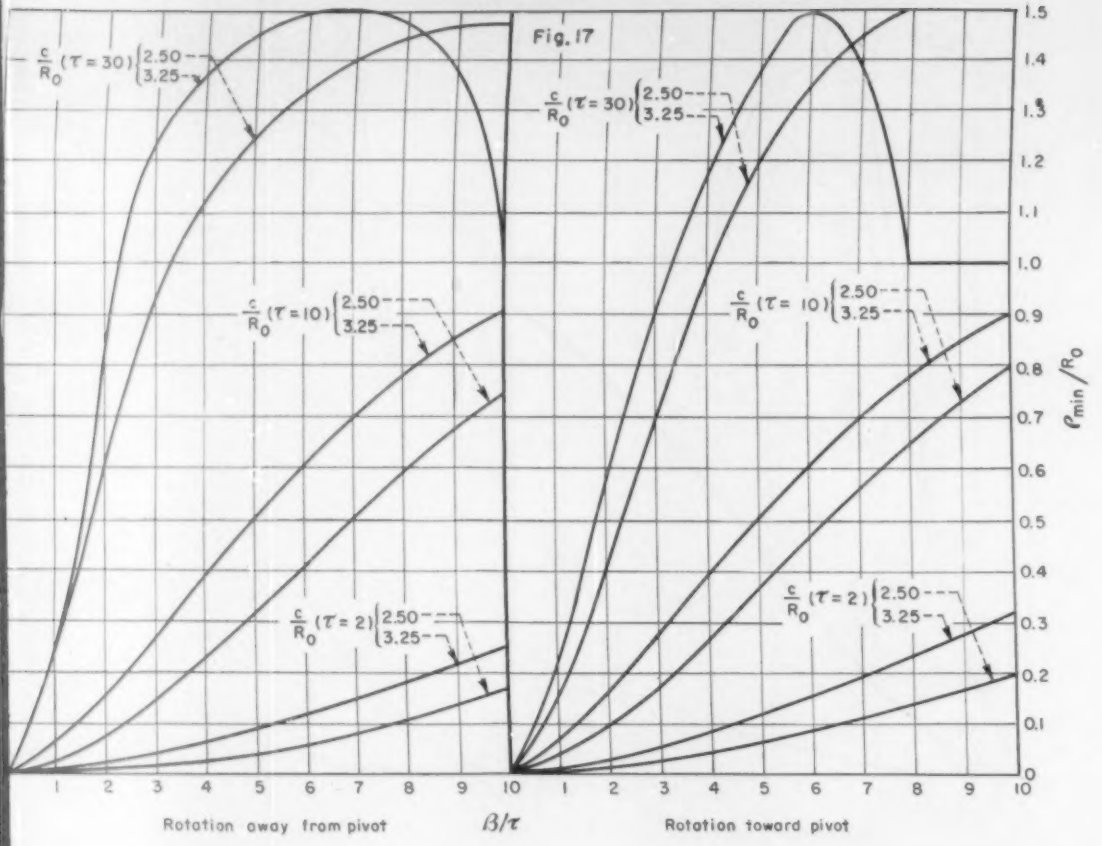
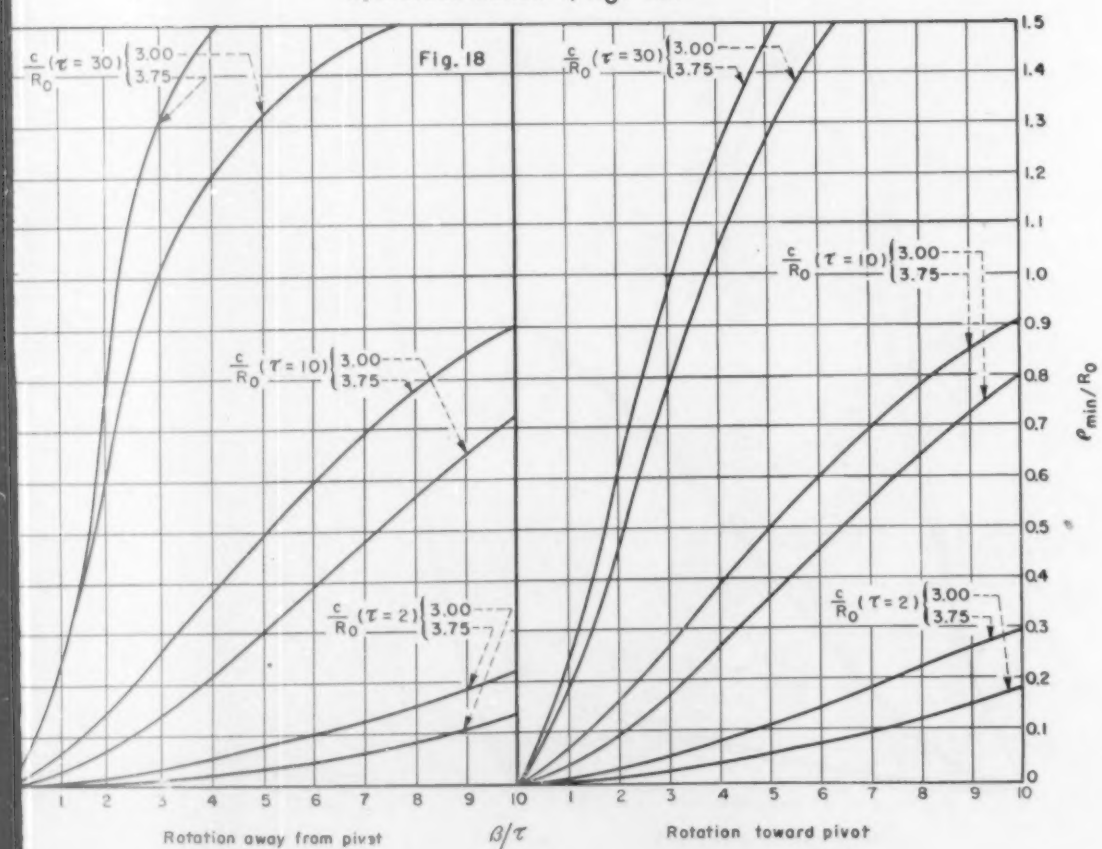
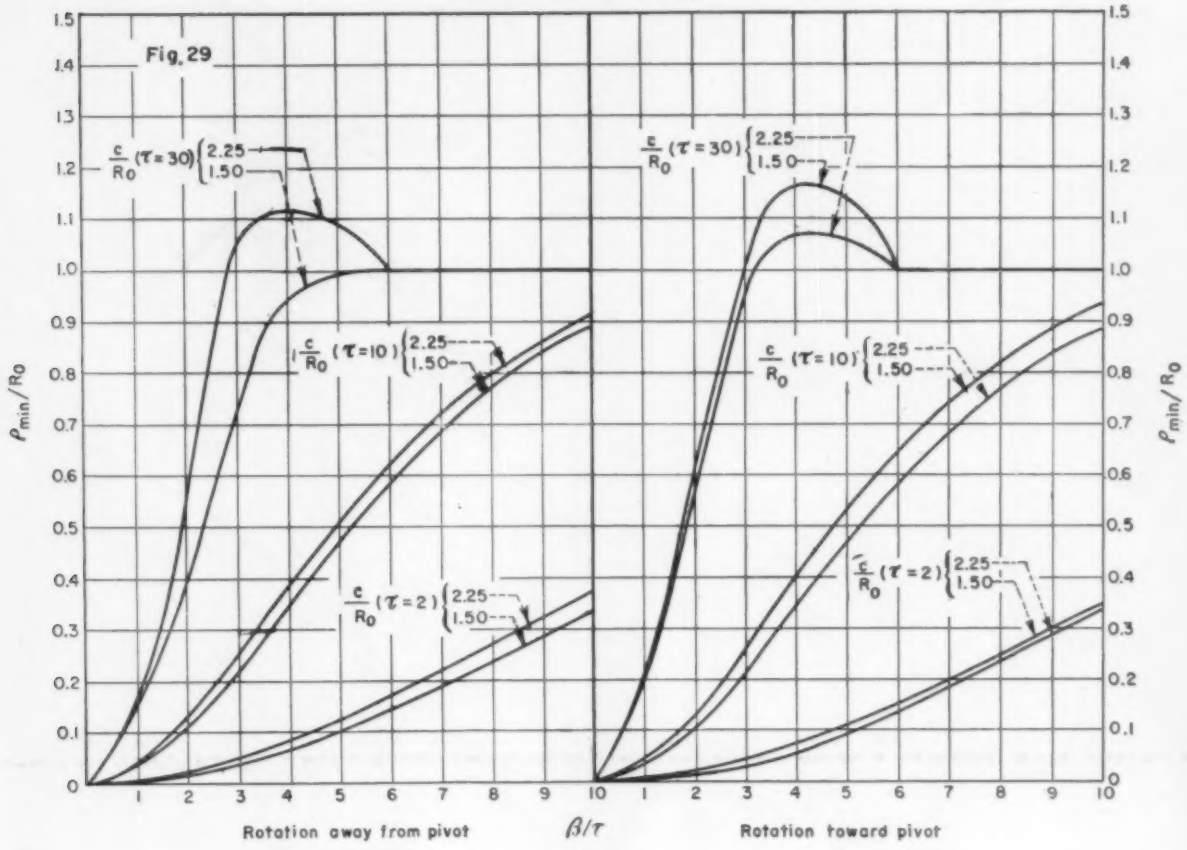
Rotation away from pivot β/τ Rotation toward pivot

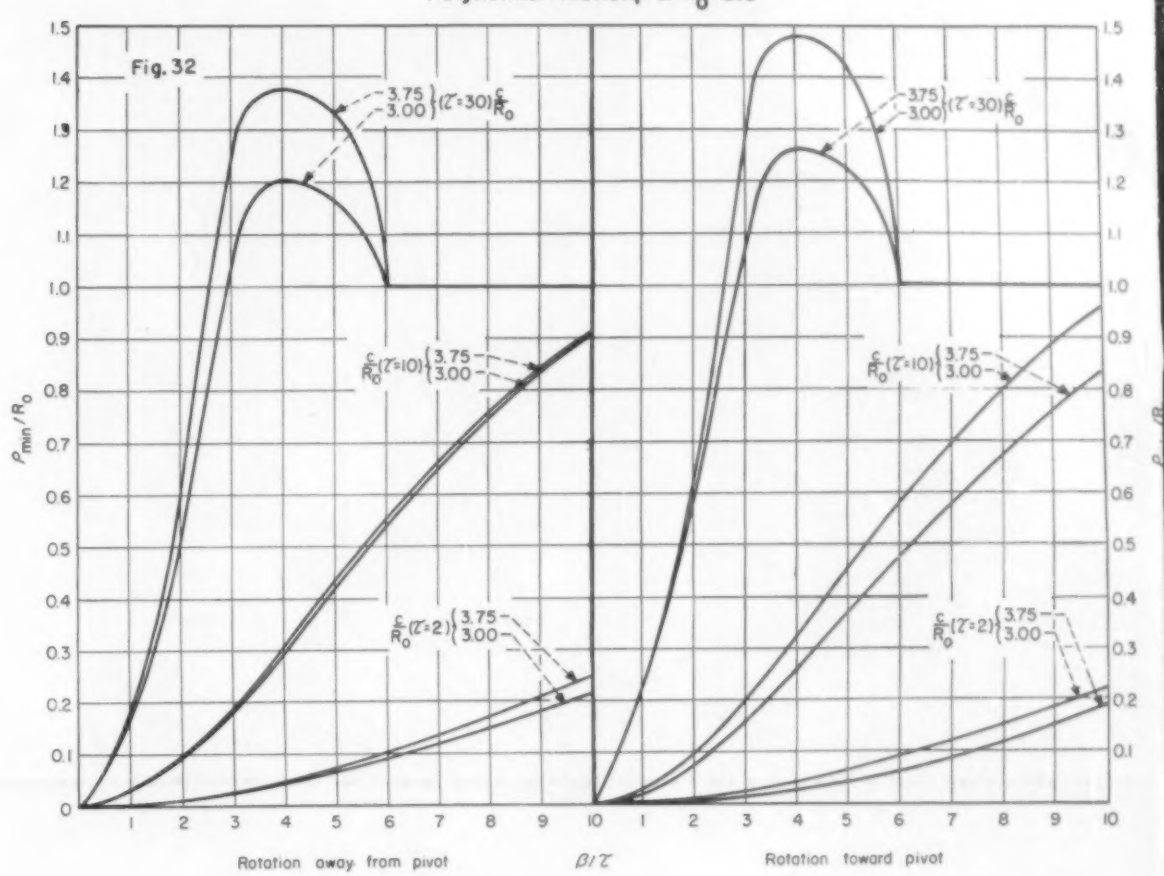
Cycloidal motion, $l/R_0 = 2.5$

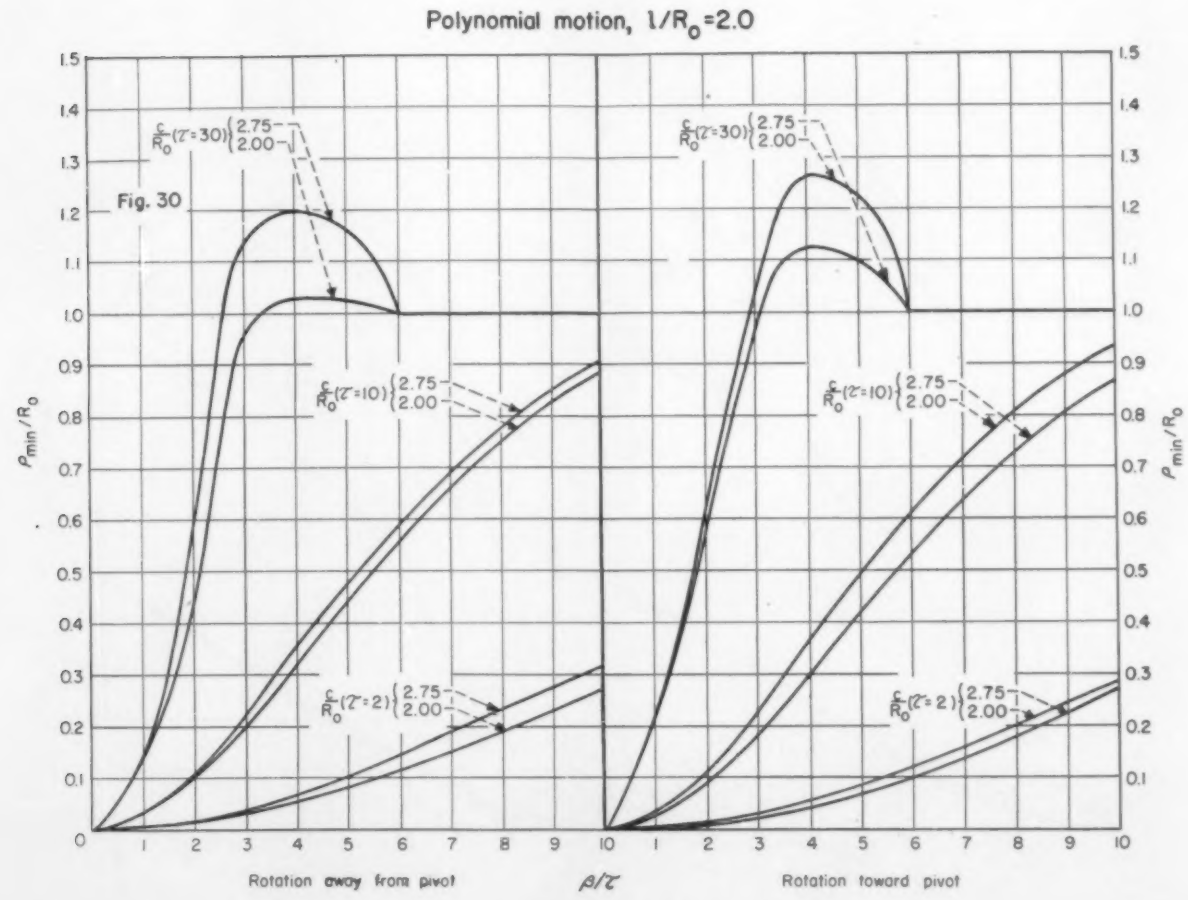


Cycloidal motion $l/R_0 = 3.0$




Polynomial motion, $1/R_0 = 1.5$
Fig. 29
$\frac{c}{R_0}(\tau=30)\{2.25, 1.50$
$\frac{c}{R_0}(\tau=10)\{2.25, 1.50$
$\frac{c}{R_0}(\tau=2)\{2.25, 1.50$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot


Polynomial motion, $1/R_0 = 3.0$
Fig. 32
$\frac{c}{R_0}(\tau=30)\{3.75, 3.00$
$\frac{c}{R_0}(\tau=10)\{3.75, 3.00$
$\frac{c}{R_0}(\tau=2)\{3.75, 3.00$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot


Polynomial motion, $1/R_0 = 2.0$
Fig. 30
$\frac{c}{R_0}(\tau=30)\{2.75, 2.00$
$\frac{c}{R_0}(\tau=10)\{2.75, 2.00$
$\frac{c}{R_0}(\tau=2)\{2.75, 2.00$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot

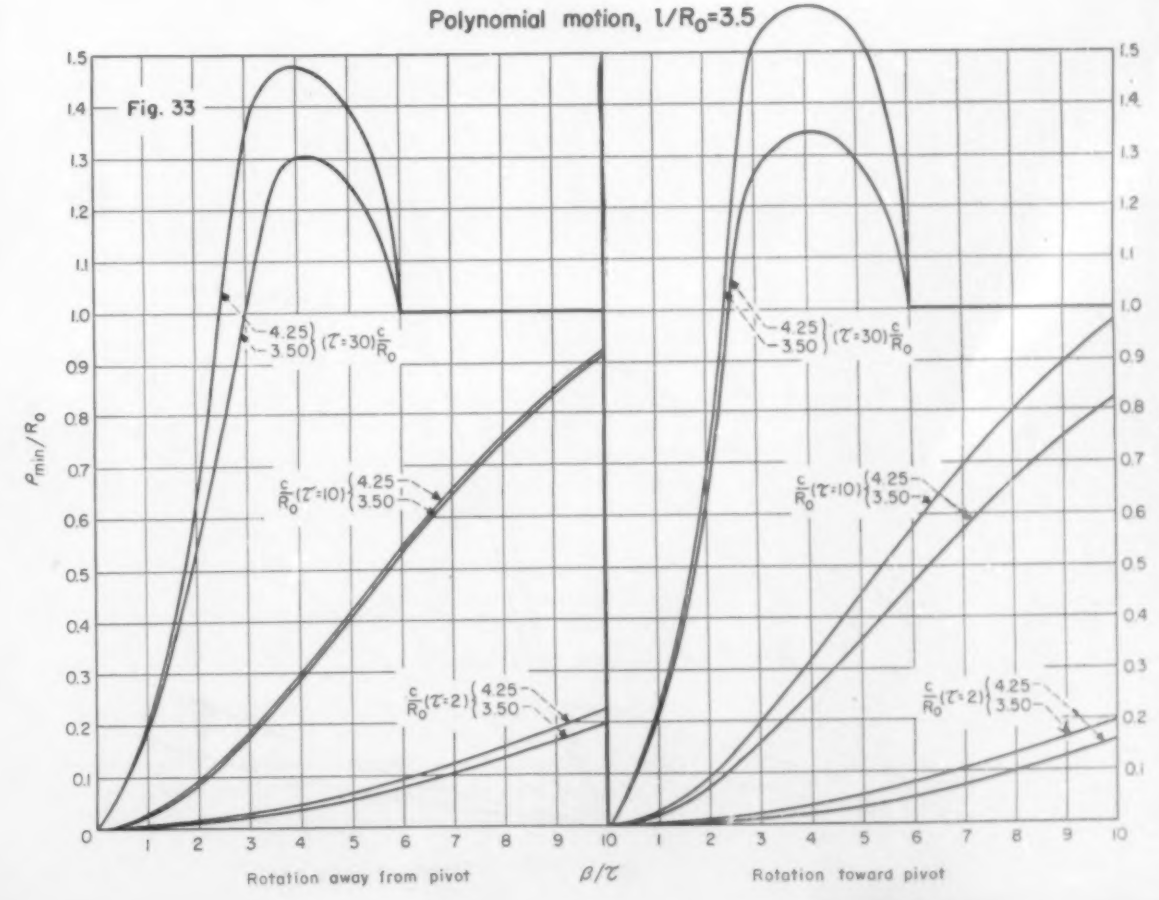

Polynomial motion, $1/R_0 = 3.5$
Fig. 33
$\frac{c}{R_0}(\tau=30)\{4.25, 3.50$
$\frac{c}{R_0}(\tau=10)\{4.25, 3.50$
$\frac{c}{R_0}(\tau=2)\{4.25, 3.50$
ρ_{min}/R_0
Rotation away from pivot
β/τ
Rotation toward pivot

Fig. 26

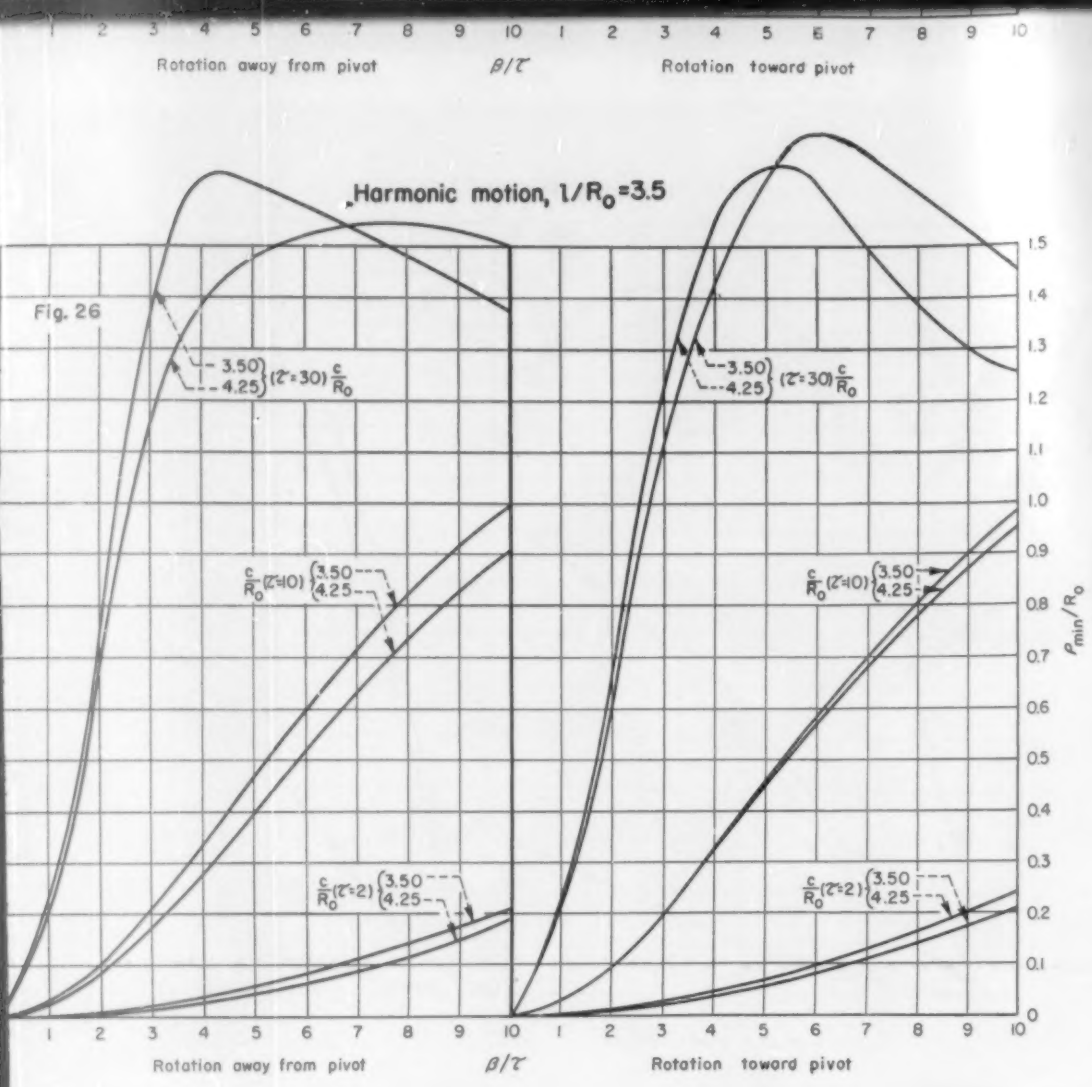
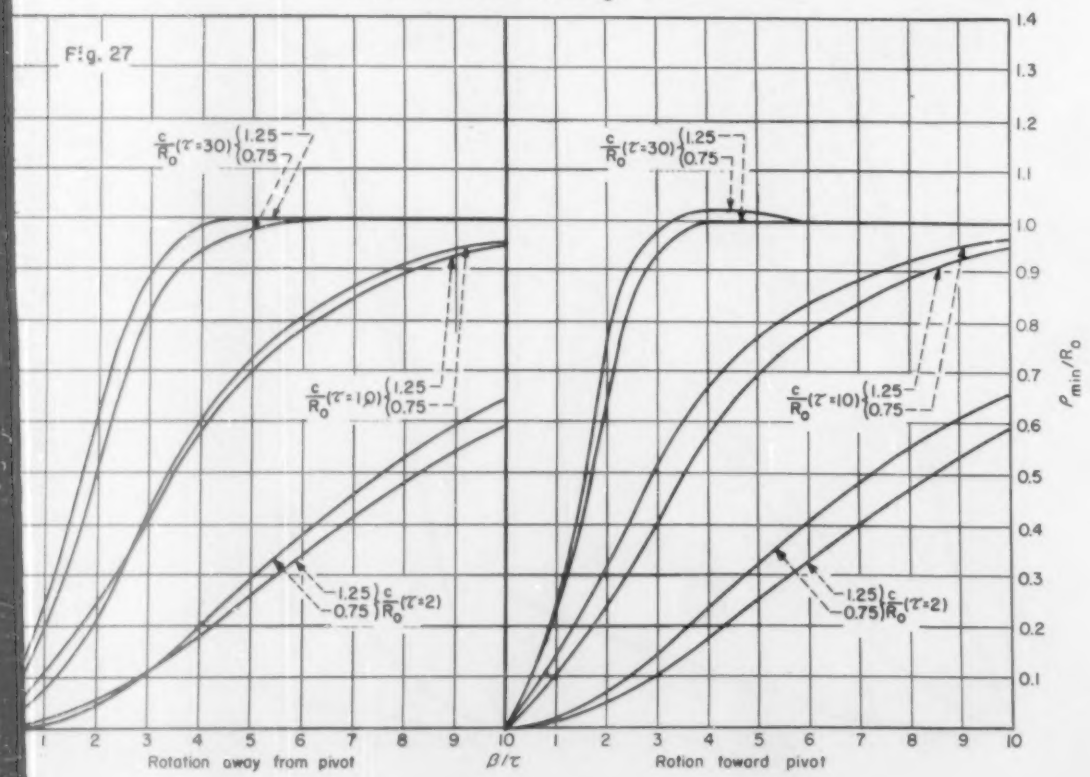
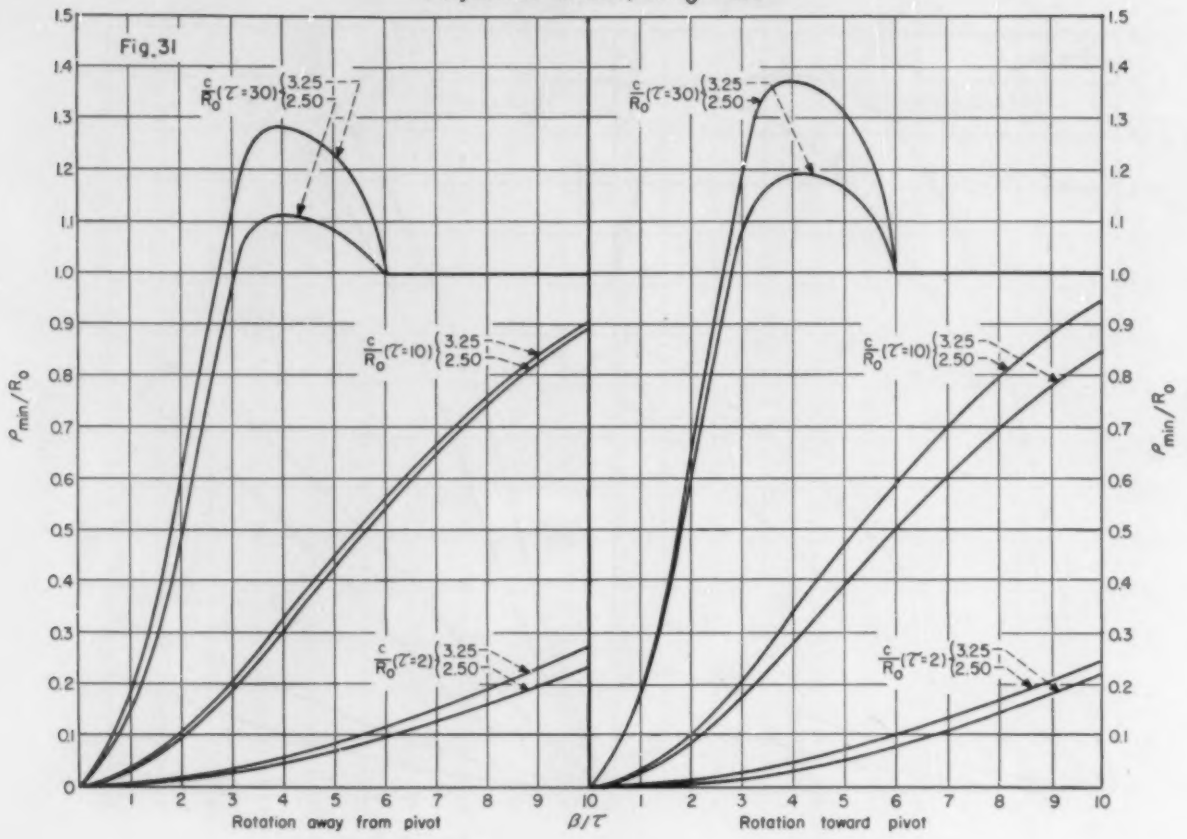

Harmonic motion, $l/R_0=3.5$
Rotation away from pivot
β/τ
Rotation toward pivot
ρ_{min}/R_0
$\frac{c}{R_0}(\tau=30)\begin{cases}3.50\\4.25\end{cases}$
$\frac{c}{R_0}(\tau=10)\begin{cases}3.50\\4.25\end{cases}$
$\frac{c}{R_0}(\tau=2)\begin{cases}3.50\\4.25\end{cases}$

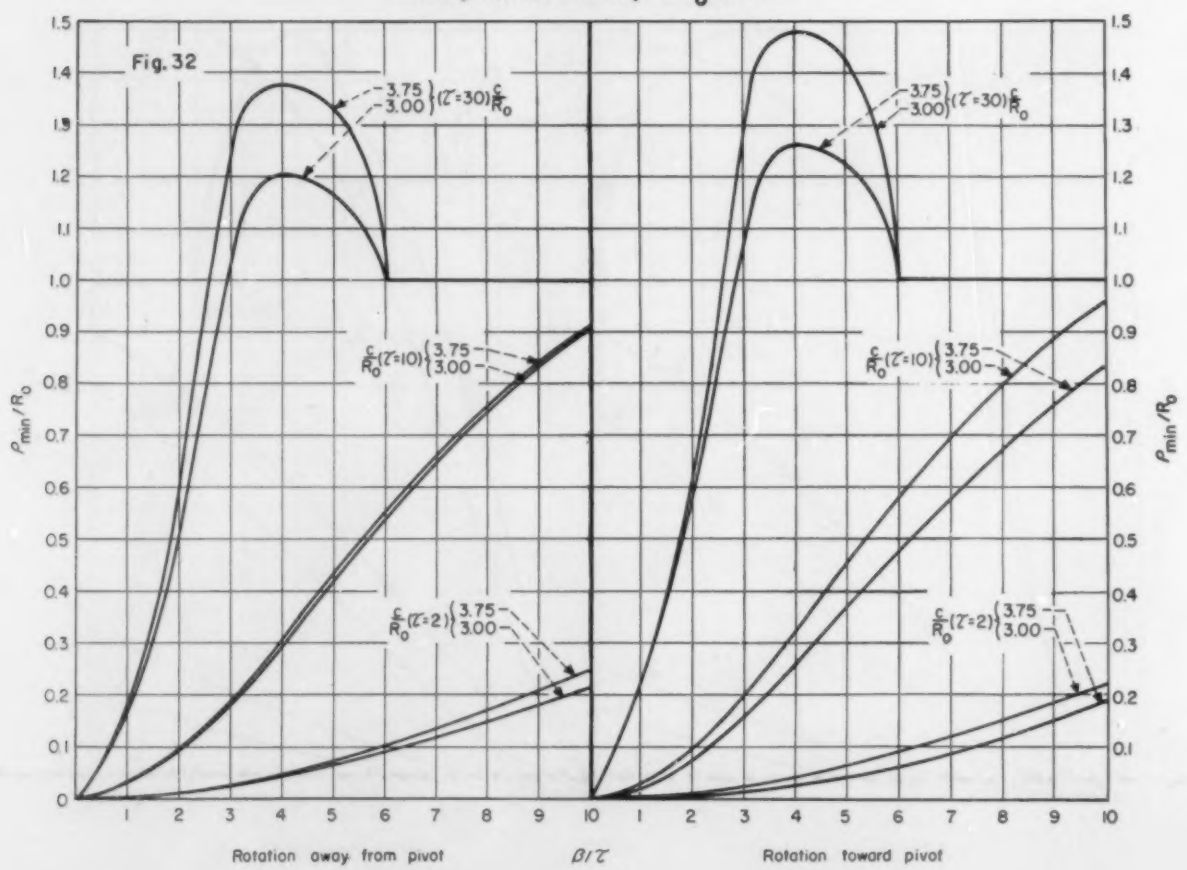
Fig. 27


Polynomial motion, $l/R_0=0.5$
Rotation away from pivot
β/τ
Rotion toward pivot
ρ_{min}/R_0
$\frac{c}{R_0}(\tau=30)\begin{cases}1.25\\0.75\end{cases}$
$\frac{c}{R_0}(\tau=10)\begin{cases}1.25\\0.75\end{cases}$
$\begin{cases}1.25\\0.75\end{cases}\frac{c}{R_0}(\tau=2)$

Polynomial motion, $l/R_0 = 2.5$



Polynomial motion, $l/R_0 = 3.0$



Spot Welding Of Structural Aluminum

—can consistently give metallurgically sound joints when weld current, weld and forging pressures, and metal cleaning are accurately controlled. Advantages over other joining methods include high production rate, no added weight, relatively smooth flush surface, and no holes in sheet to be sealed. Principle limitations are the requirement for rigid process control and examination of test specimens at frequent intervals.

SPOT WELDING OF AIRCRAFT

Spot welding of primary aircraft structures dates back to about 1931 when an amphibious biplane, the "Pioneer," was built by the Budd Manufacturing Co; this airplane is now on display at Franklin Institute in Philadelphia. In 1933, wings on the Northrup Gamma type plane were spot welded; also, the structural members (formers) used to shape or contour the skins were spot welded to the skins on the Chance Vought "Kingfisher," a pre-World War II observation plane.

One faulty joint in an aircraft assembly can cost lives and results in the loss of millions of dollars in equipment. Therefore, until reliable analytical data is available for specifying welding parameters and process control, time consuming and costly production weld testing will continue to be required to insure 100 per cent metallurgically sound joints.

The work reported here by Mr. William R. Gain is one example of a number of programs now under way to reduce welding to a more exact science. Results of such programs will surely bring welding costs down, particularly for critical joints.

WILLIAM R. GAIN
Senior Group Engineer, Boeing Airplane Company

USE OF SPOT WELDED JOINTS on structural components of aircraft has been limited because of lack of experience and knowledge of the various physical and chemical properties of such joints. Yet, much research and development work, particularly on the welding of aluminum alloys, has been carried on in recent years, and has resulted in design improvements in spot welding equipment and increased the applications for the process.

CAUSES OF WELD FAILURES. Weld inconsistencies are a function of material being welded, metal cleaning method and welding machine operation.

Material. Matallurgical uniformity of material is important if consistently good welds are to be obtained with a given setting of the welding equipment. Any change in alloy will necessitate a revision of process specifications.

Cleaning. Uniformly clean parts result if the temperature of the cleaning solution, the concentrations and the immersion time are adequately controlled. A method for checking the consistency and adequacy of the cleaning process was developed which is simply a surface low-resistance measuring device.

Welding Equipment. To produce welds of good quality and consistency, the welding current, welding pressure, forging pressure, and electrode contour are critical factors. To investigate the effect of these factors on weld quality, an oscillograph was used to record the rate of rise and decay of the current and rise of weld and forging pressure; determination being made of the desirable waveform required to obtain consistently satisfactory welds, Fig. 1. A definite relationship was shown to exist between these

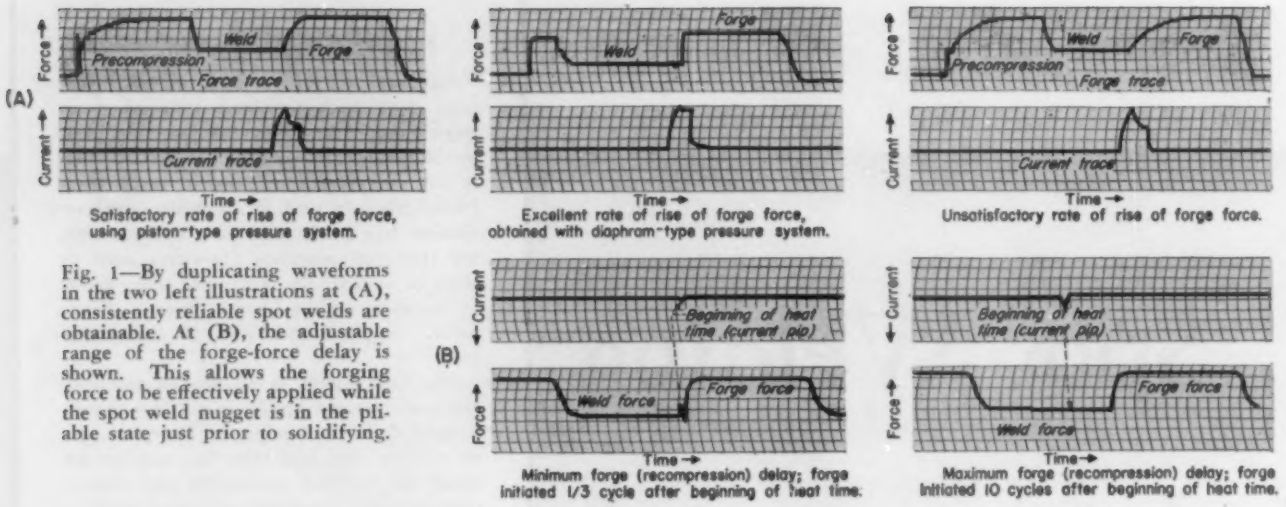

(A)
Force
Current
Weld
Precompression
Forge
Force trace
Current trace
Time →
Satisfactory rate of rise of forge force, using piston-type pressure system.
Excellent rate of rise of forge force, obtained with diaphram-type pressure system.
Unsatisfactory rate of rise of forge force.
(B)
Beginning of heat time (current pip)
Weld force
Forge force
Minimum forge (recompression) delay; forge initiated 1/3 cycle after beginning of heat time.
Maximum forge (recompression) delay; forge initiated 10 cycles after beginning of heat time.

Fig. 1—By duplicating waveforms in the two left illustrations at (A), consistently reliable spot welds are obtainable. At (B), the adjustable range of the forge-force delay is shown. This allows the forging force to be effectively applied while the spot weld nugget is in the pliable state just prior to solidifying.

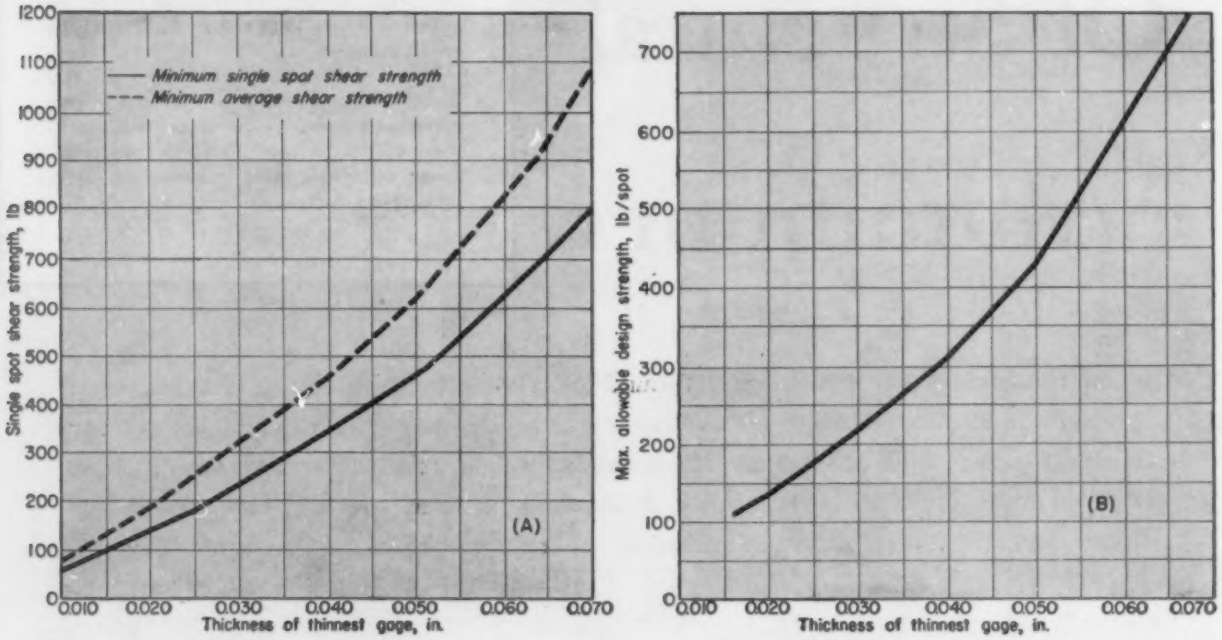


Fig. 2—(A) Minimum single spot shear strengths, required by MIL-W-6860 specification. All values of average single spot shear strength in Table I exceeded these minimum requirements. (B) Maximum allowable single-spot strengths, based on MIL-W-6860, to use in design of joints. For example, with 0.040 in. min sheet thickness, 310 lb per spot is the design max.

Table I—Strength of Spot Welds

Optimum design values for two-row spot welded lap joint to give 50,000 psi min tensile strength of joint, and failure (under static load) of base metal rather than shearing of spots. Values shown are for a spot spacing of 0.5 in., an edge margin distance of 0.38 in. and row spacing of 1.25 in.

Sheet thickness combination, in.	Average single-spot shear, lb.
0.040 and 0.040	700
0.051 and 0.051	900
0.064 and 0.064	1,200
0.072 and 0.072	1,400

various factors, and synchronous controls were developed to assure the reproduction of the required current and pressure wave shapes to produce consistent, metallurgically sound welds.

CONTROLLED SPOT WELDING. About 600 transport aircraft have been built, using accurately controlled spot welding practices; thus a good test of the applied principles has been obtained.

Most critical application was the spot welding of skin laps on the body panels. An extensive test program was conducted to develop a two-row spot welded joint to satisfy two basic requirements: ultimate tensile strength

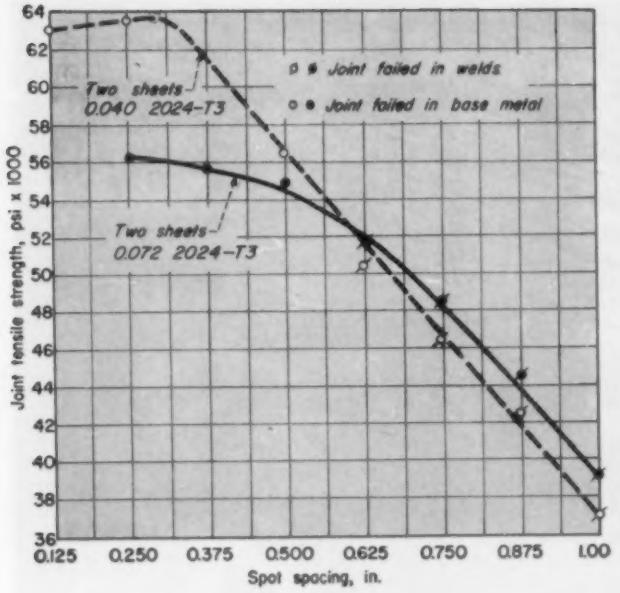


Fig. 3—Spot spacing vs joint strength. Data was obtained by test of actual production-welded joints where the weld factors were controlled in accordance with Fig. 1.

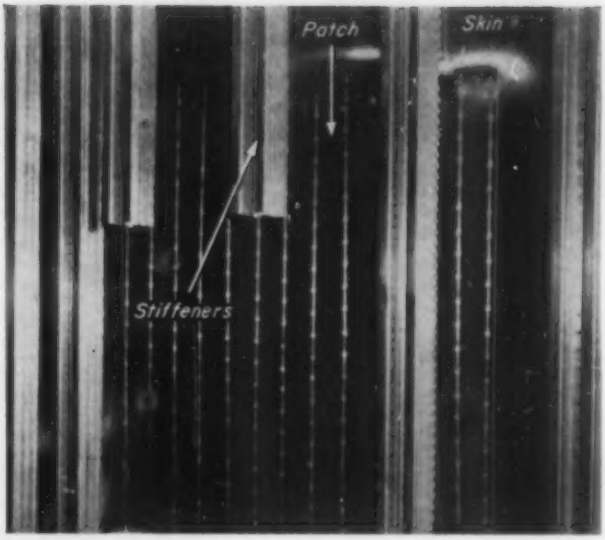


Fig. 4—Four thicknesses of sheet were spot welded under careful control of weld current and forging pressure. The sheet combination consisted of 0.040 in. and 0.064 in. skins, an 0.025 in. reinforcement-doubler patch, and an 0.072 in. hat-section stiffener. Note impression made between spots by the rolling action of the welding machine.

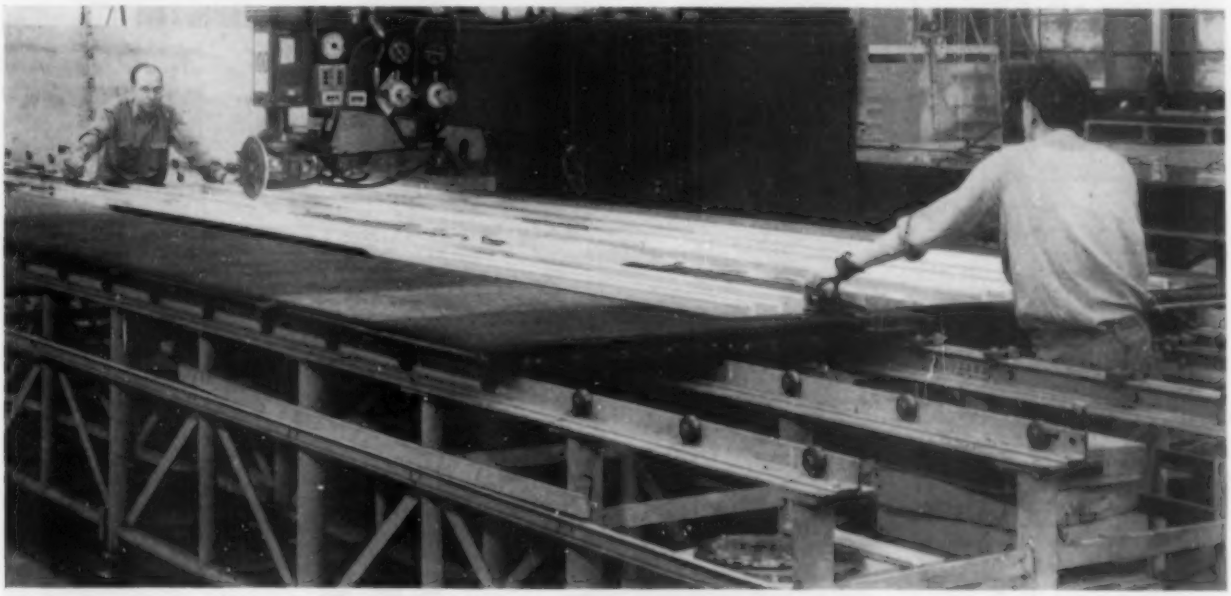


Fig. 5—Roll welding of lap joints in assembly of large body panels. Lap joints are welded at rate of 40 spots per min.

of the lap joints in excess of 50,000 psi; and joint fracture at ultimate static load to occur in the base metal and not by shearing of the spots. Optimum values, shown in Table I, were obtained for (1) spot spacing, (2) edge margin, (3) row spacing, and (4) single spot shear strength. These values are not necessarily those that give maximum joint strength but those which just satisfy the two basic requirements listed. Strength requirements of individual spots had to conform to MIL-W-6860 specification shown at (A) in Fig. 2; and in designing a joint with multiple spots, maximum allowable single spot strengths are given at (B).

Economic factors entered the picture at this point; the possible benefits of obtaining additional strength over minimum requirements were weighed against cost of greater production time, additional weight, and difficulty in standardization. For example, Fig. 3 shows the effect of spot spacing on ultimate tensile joint strength; higher strengths are obtainable with both 0.040 and 0.072 in. sheet with closer spot spacing than 0.5 in. However, the 50,000 psi strength requirement is met in each case with 0.5 in. spot spacing. To minimize production time and facilitate standardization of the indexing table racks 0.5 in. spacing was selected. With heavier sheet thicknesses, new values of edge margin, row spacing and spot spacing would necessarily be required. Higher

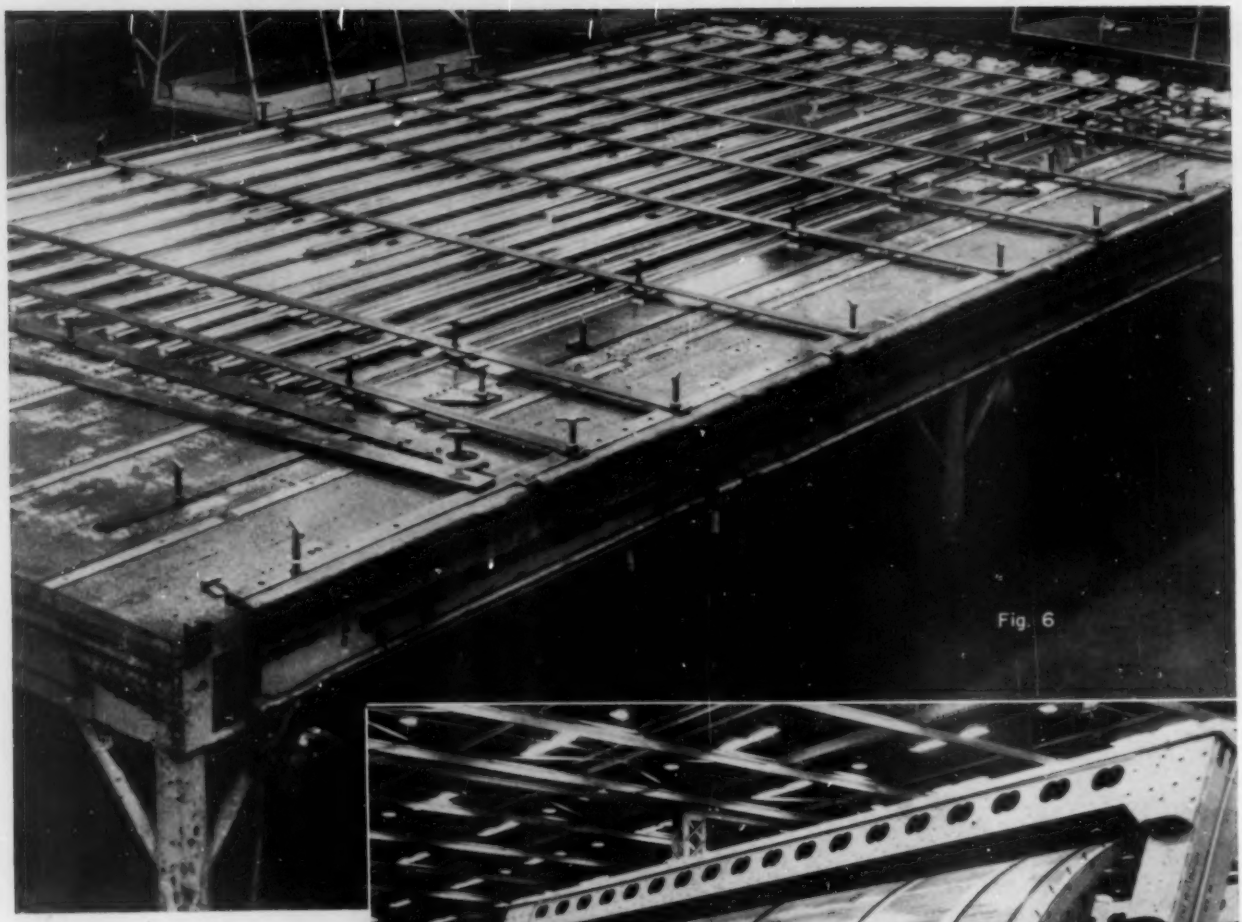


Fig. 6

Fig. 6—Tables for holding panels preparatory to welding. Up to 10 x 20 ft panels can be accommodated. Each aircraft has 21 panels of varying sizes; and two tables like that shown can accommodate panels for 20 airplanes a month

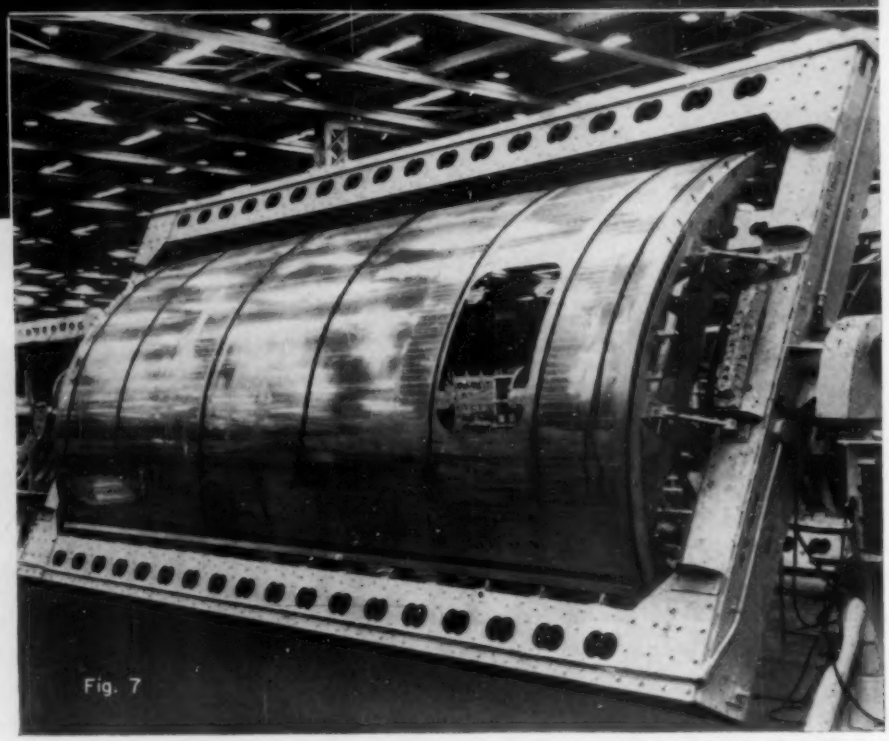


Fig. 7

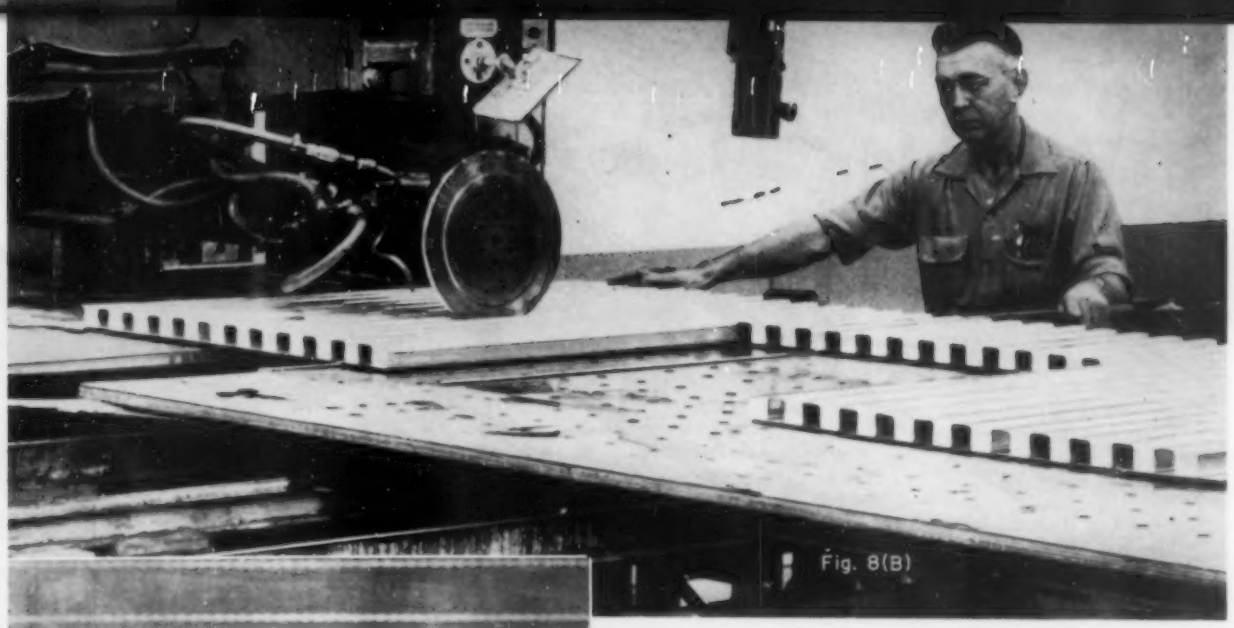
Fig. 7—After spot welding of skin laps, longitudinal stiffeners and reinforcement doublers, while in a flat position (Fig. 5), the panel is assembled to circumferential stiffeners in rotatable wrap-around fixtures.

single spot shear strengths would also be necessary.

A typical structural body panel is shown in Fig. 4. Welding of the skin lap is done according to data in Table I while joining of the stiffeners and patches is done under slightly less rigid control of weld factors. As many as four thicknesses of sheet were involved in carrying out the "special welding" at points where a reinforcement doubler for a cut-out area crossed a lap joint containing a hat-section stiffener, as shown.

A lap joint being roll spot welded at the rate of 40 spots a minute is shown in Fig. 5. The patches and stiffeners are also roll spot welded but at a speed of 70 spots a minute.

The large fuselage panels (up to 10 x 20 ft) are assembled on layout tables as shown in Fig. 6. Component parts are drilled approximately every 20 inches for temporary fasteners, code marked for disassembly and cleaning, and then reassembled for welding. The patches, stiffeners and splice joints are welded in the flat. Then they are assembled to the circumferential



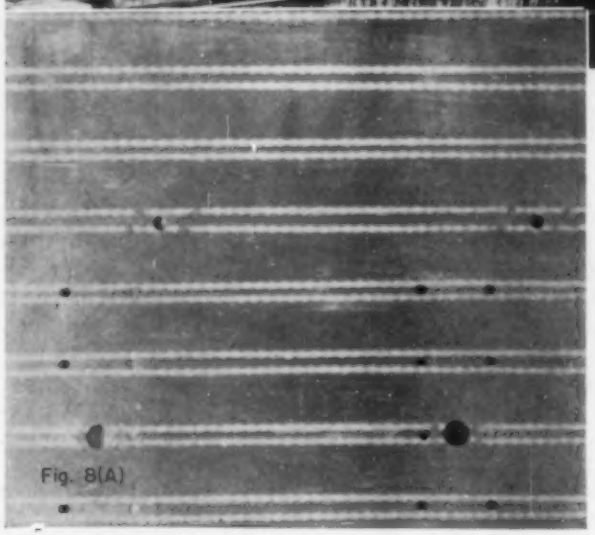


Fig. 8—(A) Section of flat floor panel showing spot welds accomplished by roll spot welder. (B) Close-up of welding operation which progresses at the rate of 90 to 110 spots a minute. External flood cooling prevents panel warpage.

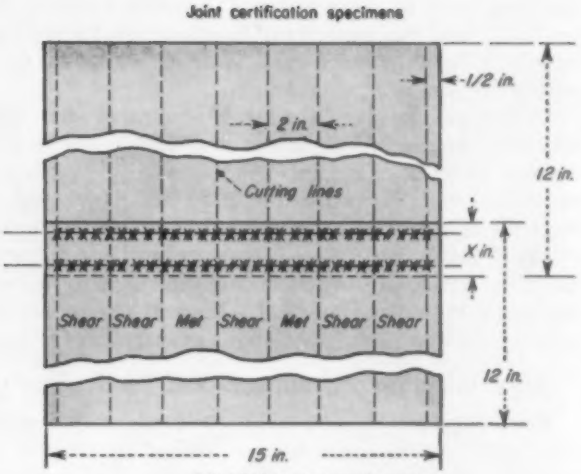


FIG. 9 (A) Joint strength panel

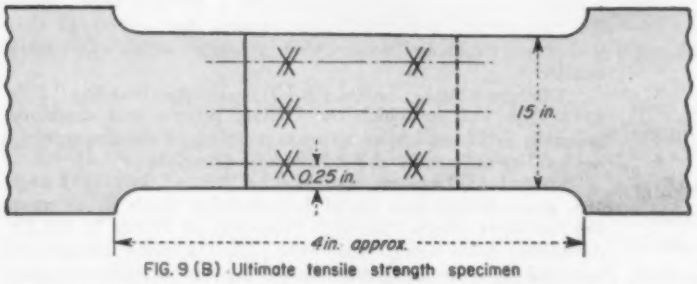


FIG. 9 (B) Ultimate tensile strength specimen

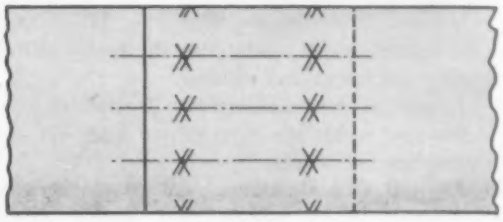


FIG. 9 (C) Specimen for metallurgical examination

Fig. 9—Specimen (A) is divided to provide test specimens; five for strength tests (B) two for metallurgical examination (C).

stiffeners in the wrap-around fixtures shown in Fig. 7.

In the roll spot welding of flat floor panels, shown at (A) in Fig. 8, 90 to 110 spot welds per min are applied and at a spacing of 0.62 in. as at B. To minimize warpage, external flood cooling is used.

CONTROLLING QUALITY Before production welding begins, and to develop a welding schedule for a body skin lap joint, a test panel is welded as at (A) in Fig. 9. This test panel is then cut into seven specimens as indicated. Five specimens like that shown at *B* are tested for ultimate static tensile strength, and two as at *C* for metallurgical competence. Metallurgical examination should show the welds to be free of cracks, voids and porosity and weld penetration within limits of 30 to 80 per cent of base-metal thickness.

In addition, a 20 weld single-spot shear test panel is cut and tested for each welded interface to establish the single spot shear strength average and consistency.

Surface preparation consists of chemical cleaning and

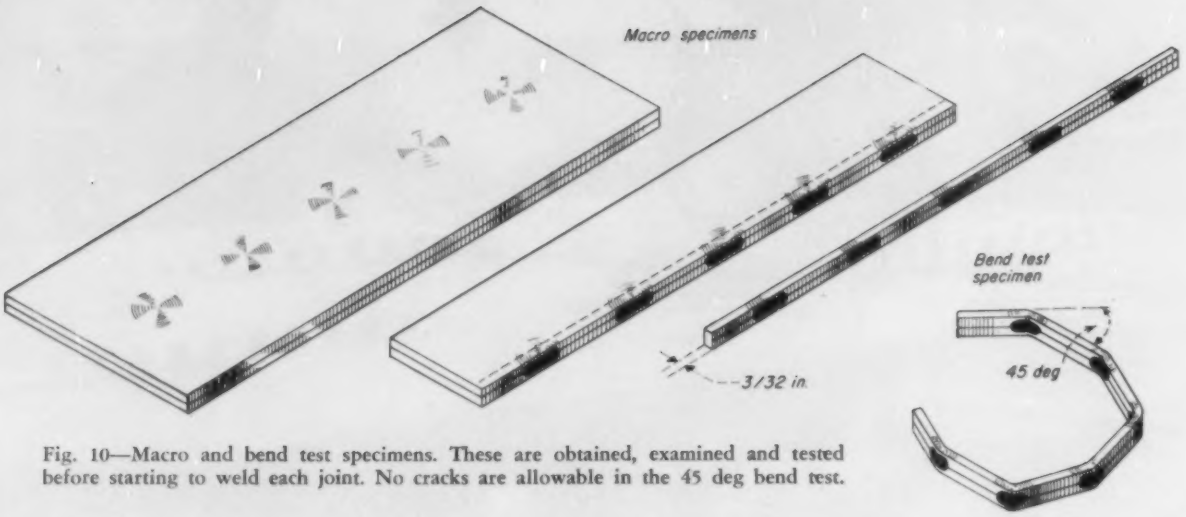


Fig. 10—Macro and bend test specimens. These are obtained, examined and tested before starting to weld each joint. No cracks are allowable in the 45 deg bend test.

deoxidizing until a surface resistance of 50 microhms max results; then, faying surfaces are wire brushed. This brushing must be done within 8 hrs after chemical deoxidizing, and the parts must be assembled for welding within ½ hr after brushing. Welding must be done within 24 hrs after deoxidizing.

During production, a three-weld single-spot shear test specimen for each interface is cut and tested before starting to weld each joint. Also, macro specimens are examined, Fig. 10; when the 3/32 in. wide strip is bent through 45 deg across the weld faces as shown, no cracks should appear. Repeat tests are made at frequent intervals during production and when any critical control factor is suspected of change, such as replacement of welding electrode, change of alloy or condition of sheet.

Spot Welding Advantages and Limitations

Economic Factors. The rapid rate at which spot welds can be made makes this joining method economical in spite of the large number of specimens that must be tested. The average cost of assembling and spot welding on the body panels described is $0.022 per spot. This cost includes shearing of the skins, layout and assembly time, cleaning cost, setting up the spot welding machine, testing specimens and welding.

In general, spot welding is not economical where only a few spot welds are required per assembly unless many assemblies are involved.

Physical Considerations. Advantages of spot welding include (1) flush surface after joining, (2) no added weight imparted, and (3) no break in skin which must be sealed. Thus, for certain applications spot welding is the most economical joining method, giving good strength and quality of joint.

Fatigue tests are being conducted; but as yet, no definite conclusions can be stated. Indications are that fatigue life is increased by adding a third row of spot welds; yet this third row gives no apparent increase in static joint strength. For example, fatigue life varied from 33,000 to 52,000 cycles for an 0.040 to 0.040 in. butt splice with 0.064 in. splice plate, where two rows of spots were used (1 in. row spacing and ½ in. spot spacing). With three rows of spots (½ in. row spacing and ½ in. spot spacing), fatigue life was from 66,900 to 142,800 cycles. Static strengths, however, were 51,400 psi and 52,400 psi, respectively. In conducting these fatigue tests, the mean stress level was 8,000 psi; the amplitude ± 7,700 psi.

A test program is also planned to determine the effect of the internal structure of the spot weld on fatigue life. This test will compare the fatigue strength of welds which contain internal cracks as indicated by radiography, welds which radiography shows are crack free but will not meet the bend test, and welds which meet the bend test.

Some prior work, on which this article is based in part, was reported in the following references:

"The Application of Spot and Seam Welding To Design" by Jenkins and Piper; Welding Journal, September, 1951, page 803.

"Development of a Two-Row High Strength Spot Welded Lap Joint in 24S-T Alclad Aluminum Alloy" by L. M. Crawford and J. E. Pease; Welding Journal, December, 1946, page 1203.

EDITOR'S NOTE—Recent articles in the continuing *Product Engineering* series on welding of sheet materials include:

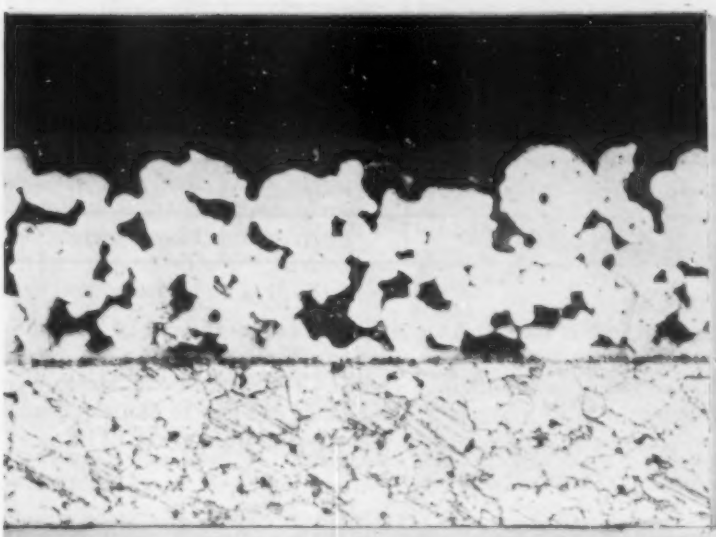
"Spot Welding From One Side With A Portable Gun," using the inert-gas shielded tungsten-arc process, Apr. 1955 page 180; with applications and a discussion of factors which affect weld quality.

"A Progress Report on Shielded-Tungsten Arc Welding," Feb. 1954 page 170, in which the Heliarc process was described primarily with application to seam welding of aluminum, magnesium, stainless steel and other sheet materials.

"Strength of Titanium Spot Welded Joints," July 1954 page 193, gives design data useful in specifying welds in titanium and the super alloys. "Strength Properties of Welds in 61S-T6 Aluminum Alloy Sheet," June 1952 page 148, gives strengths of butt and lap joints using the inert-gas process on aluminum-alloy sheet. "Spot Welding Highly Stressed Aluminum and Magnesium Assemblies", March 1952 page 185, illustrates typical welds and gives weldability data, including spacing of spots, on aluminum alloy and magnesium sheet combinations.

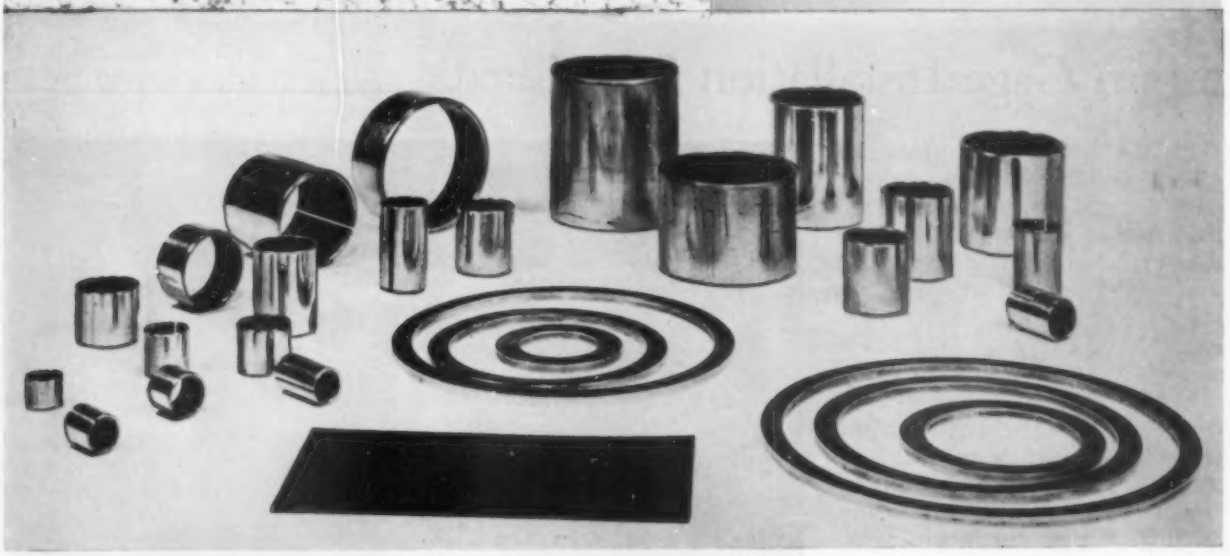
In the area of sheet-metal fabrication, a recent article, "23 Design Tips for Sheet Metal Fabrication," May 1955 page 166, described cost-saving techniques in fabrication design. Two recent articles offer suggestions on strengthening sheet metal panels: "Sheet Metal Beading," July 1955 page 183, and "Waffle and Lattice Beading," Aug. 1955 page 171.

Advantages, limitations and design considerations of spot welding as compared with other types of resistance welding are tabulated on two sides of a 20 x 20 in. chart, "Fundamentals of Resistance Welding," published in the 1954 Annual Handbook, page G23. A limited number of reprints are available on letterhead request.



FOR MOST APPLICATIONS, a porous bronze layer is sintered onto a steel backing and then impregnated with Teflon. In a continuous process, a thin layer of bronze powder applied to a steel strip, and sintered. The strip is then impregnated with the plastic.

FOLLOWING THE PLASTIC IMPREGNATION PROCESS, thrust washers, bearings, and bushings are blanked, pressed, and machined from this strip. The bearing surface must not be damaged during these stages, and cannot be machined. Bearings are finished to small tolerances, and need not be lapped, or ground before using. At present, bearings of standard sizes from $\frac{1}{4}$ to 2 in. shaft dia. for the thrust washers and wrapped bushings are being made.



Plastic Impregnated Bearing Runs Dry

Among the good properties of Polytetrafluoroethylene (PTFE) (Teflon) is its dry coefficient of friction of about 0.05 against itself or any other material. Any wear which does take place with a PTFE surface is due solely to the roughness of the mating surface cutting through the PTFE. After a while, the rough surface becomes filled with PTFE and little, or no further wear takes place. However, because of poor thermal conductivity, and cold flow under light loads, bearings of solid PTFE are limited to conditions of light load and low speed.

To overcome these latter disadvantages, Glacier Metal Co., Ltd., Alperton, Wembley, Middlesex, England, has developed methods for impregnating a porous metal matrix with PTFE. This combines the strength, heat conductivity, temperature, and size stability of the metal matrix with the good friction, chemical, and year properties of PTFE. The purpose of the surface layer of this plastic (see illustration) is to fill any roughness on the mating surface to give a good bearing combination. Another advantage of this interlocked structure is that when the surface layer of PTFE becomes damaged, a local high temperature spot is produced which causes the plastic to flow out of the metal matrix and "heal" the damaged part of the bearing.

In the new PTFE bearing, its load and speed capacity are determined by its ability to dissipate heat. The limits of load and speed are determined by a constant product of bearing pressure (P-psi), and surface speed (V – ft/min). Tests conducted by Glacier Metal Co. both in the laboratory and in the field were over a range of conditions varying from 5 to 2,000 psi, and from 10 to 1000 ft per minute. It was found that these PV factors

are applicable except at speeds over 500 ft/min. Above these speeds, air tends to be sucked into the bearing and acts as a lubricant, so that loads higher than those shown in Table I may be carried.

These values of load and speed are based on results with a mild steel shaft with a good surface finish. The PTFE bearings were in the normal prefinished condition. Other shaft materials, such as alloy steels, cast iron, and hard anodized aluminum may be used. Also, the PV values given in Table I can be raised greatly by treating the shaft with a coating of PTFE, lead or chrome plating, or an Mo S_2 coating.

The maximum operating temperature of these bearings is the softening point of the PTFE, 620 F. The bearings are designed mainly for use without a liquid lubricant. However, such a liquid will be an advantage in that it increases the rate of heat dissipation. Thus, the PV values can be raised. The increase will depend on the liquid and may be limited, because many liquids do not wet PTFE.

Table I

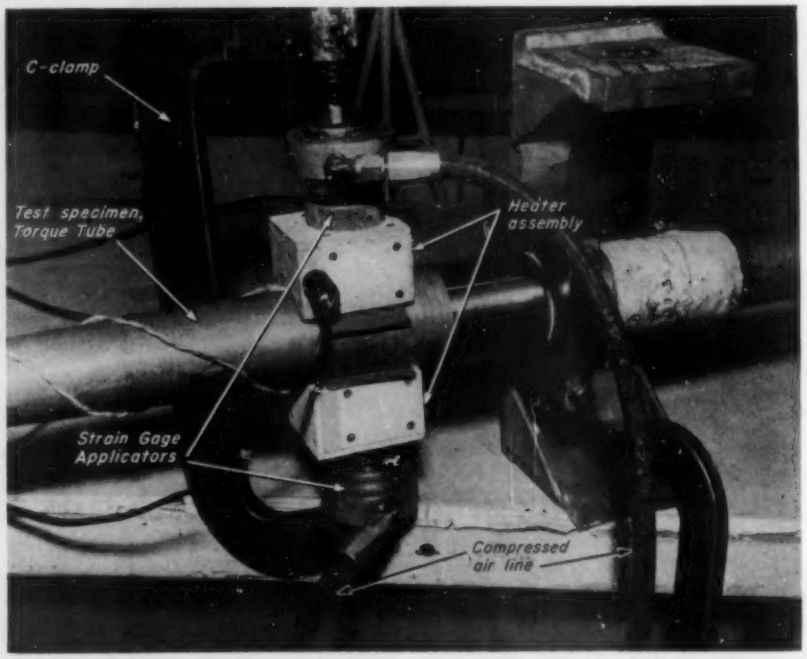
Type of Load	Normal PV	PV—Special Circumstances
Thrust Bearing	5,000	up to 15,000
Journal Bearing, Uni-directional Load	4,000	up to 8,000
Journal Bearing, Rotating Load	16,000	up to 30,000
Journal Bearing, Oscillating Load	18,000	up to 60,000

Strain Gage Installation Simplified

With the assembly line production of test aircraft and guided missiles came the need for adequate tools and techniques to simplify and speed up the installation of strain gages. This was particularly true at Boeing Airplane Co. where the Bakelite type gages are used. These gages, which are impregnated with a phenolic resin, need heat and pressure during installation to get proper bonding to the test piece. Boeing found that heat lamps, improvised ovens and spring clamps were impractical where a large quantity of gage installations is required, and developed their Strain Gage Applicator.

This self-contained device consists of two main units: a pneumatic pressure actuator and a heater assembly, and only requires connections to an air supply and electrical power source. The piston has a cavity and retaining spring to provide a quick disconnect coupling with a stud on the heater assembly. Through this connector, the actuator applies a loading pressure on the heater assembly during the bonding process.

The heater assembly has cartridge type elements rated at 30 watts each. The quantity of these elements varies according to temperature requirements, but for standard sub-assembly aircraft structures, five to ten elements will produce a temperature of 250 F.



The heat assembly can be made in any number of shapes for specific structure contours, and in many cases, adapter shoes can be fitted to existing heater elements.

The specifications for a typical applicator are: pressure actuator height, 2 in.; piston displacement $\frac{7}{16}$ in.; heater assembly height, 1.25 in.; base area 3.5 sq in.; max chamber pressure, 1500 psi; operating chamber pressure, 250 psi; max strain gage pressure, 200 psi; strain gage curing time, 6 hours.

The applicator is set in place upon the silicone resilient pad, and attached to the structure by a C-clamp or supporting bracket. A constant pressure source is needed to handle the actuator volume change as the resilient pad compresses, cement squeezes out, and supporting structures deflect.

New Comets On the Way

The DeHavilland Comets, which received a flood of bad publicity following several crashes (*Product Engineering*, January 1955, page 197), are showing up again at the DeHavilland plant, as that company begins a comeback into the business of selling pure jet commercial airliners.

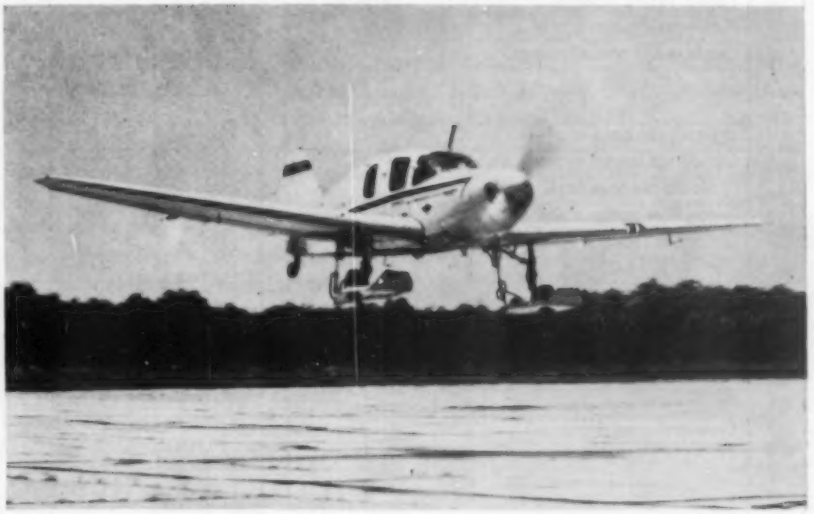
The complete line of the Comets have been classified as I, II, III, and IV. Comet I, the disaster model at Naples and Elba, has been withdrawn completely from commercial service. All will be dismantled for extensive component testing.

Comet II has been dropped as a commercial venture, but the company will deliver two to the airlines if they still want them. Four Comet II's are now flying, and the Royal Air Force will buy between 8 and 12 as high speed transports after they have been strengthened and fatigue rated in the water tank tests.

A larger model, Comet III, has flown unpressurized for more than 100 hours with good results. However, the Comet III will not be produced in quantity, and is strictly a prototype of the more powerful Comet IV, which DeHavilland expects to have in service in 1958. This will be the 58 to 76 passenger, 500 mph intercontinental plane which DeHavilland had in mind with Comet I, until the crashes began.

Incorporating some of the data of the recent "water tank" tests, the skin of a 4 ft panel along both sides of the Comet fuselage is being changed from 22 gage to 19 gage. Square windows and escape hatches have been redesigned to 14 x 17 in. ovals which will be strengthened by 10-in. wide, 20 gage doubler plate around each cutout reinforced by the 14 gage flanges of the window frame. Around all windows and escape hatches, rivets were moved $\frac{1}{8}$ to $\frac{3}{8}$ of an inch farther back from the cutout.

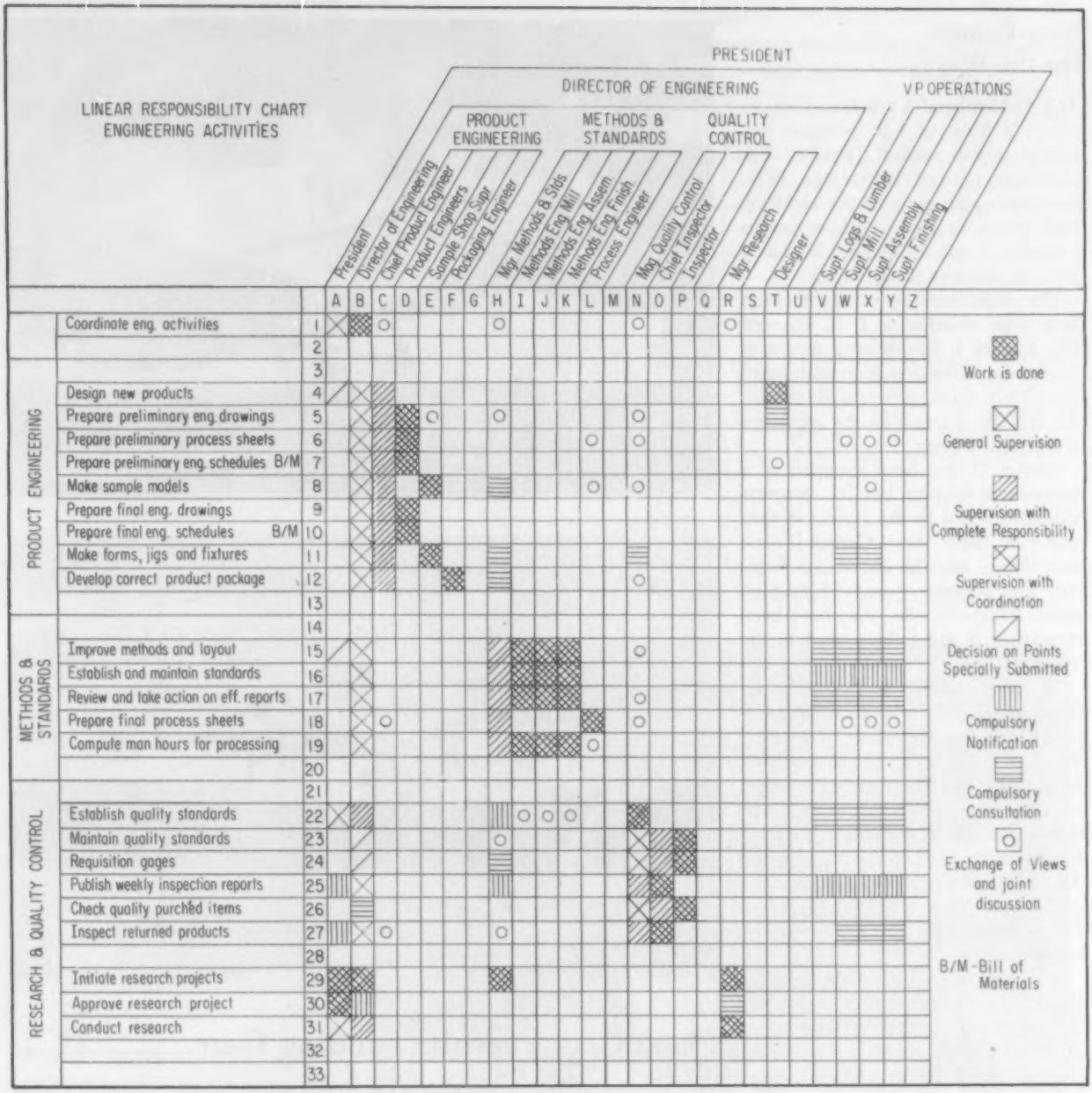
In last fall's inquiry into the Comet disasters, it was learned that in actual shop practice, the rivet holes were placed closer to the cutout than the design specified. The object in moving the rivets farther from the edge of the cutout is to reduce the cumulative local stress effects of the two cutouts.



Plane Gets Versatile Landing Gear

Water, snow, muddy swampland, and conventional airport runways can be an operations base to a plane equipped with the hydro-lift landing gear. Made by the All American Engineering Co., Wilmington, Del., the gear is fully retractable, weighs less than 100 lb., and reduces the speed of the test plane shown here (a Bellanca Cruisemaster) by only two knots. Working on the same principle as water skiing, the ski-fitted plane will ride on top of the water at a speed of 15 mph or more until the pilot taxies onto a beach or wooden ramp. On the take-off the procedure is reversed; the plane starts from the beach to pick up speed before turning into the water. (The hydro-lift is not the same as the Convair Sea Dart's hydro-skis, which are for water operation only).

The gear has been fitted to fixed landing aircraft (a Piper Cub), and is being evaluated by the military on a Navy SNJ (T-6) and an OE liaison plane. According to All American, the hydro-lift landing gear can be designed to accommodate any plane, including: long range bombers which could be based along the shore line rather than an airfield; jet fighters; large air-cargo or attack-transport planes; on commercial airlines which could operated on a river or lakefront closer to the center of a city; and for the private plane.



Who Does What to Which?

Called Linear Responsibility Charting, the boxed-chart arrangement shown here is a new approach to management organization which was developed by the Serge A. Birn Co., Inc., 614 S. Fifth St., Louisville, Ky., management consultants. The approach is unique in that it can be used by any type or size of company, or by any department within any company, i.e., sales; finance; production and engineering; servicing; advertising; and so forth. The method is supposed to replace the familiar box type of organization chart, but goes much further in that each important job function is listed, and the particular job responsibility of the various members of the organization or department is clearly indicated.

Along the top of the chart are listed the personnel within the organization, and on the left side are listed the important jobs to be done. The extent of the responsibility of the personnel to the jobs are denoted by the eight symbols on the right side. These symbols range from "work is done," meaning that the individual actually performs the function, down through two degrees of supervision and including cooperative or consulting work.

In the box at the intersection of the individual and a job is drawn the symbol for that man's responsibility to the job. Duplication and overlap-

ping of responsibilities are shown up.

A detailed analysis of personnel responsibility can be made on the basis of how much time the individual spends in supervisory, executive, or directly responsible functions. The vertical column also gives an over-all view of an individual's job responsibilities, and consequently the qualifications required for the position. The horizontal row shows the flow of responsibility on any particular job.

In practice, the number of major responsibilities is restricted to 50 or 75 items to keep the chart to a convenient size. When this amount is exceeded, separate charts may be constructed on the basis of divisions within the organization or department. The Birn system is flexible enough to permit variations in job function and responsibility without a major revision of the organization chart.

Bill in Congress Would Double Patent Filing Fees

A bill, H.R. 7416, which would approximately double cost of filing a patent is getting some action in Congress. The bill would make the first change in patent fees since 1932. So far, a committee has taken testimony from many industrialists who indicated that the increases were higher than necessary. The committee, however, agreed with the Patent Office on the increase, feeling that it would more accurately reflect the difference in costs of processing simple and complicated patents.

Under the new proposal, the fee paid would be a graduated one. On filing, $40.00 would be paid, plus $2.00 for: (1) each claim over five; (2) each page of specifications over ten; (3) and each page of drawings over one. Final fee to be paid when the patent is issued would be $50.00, plus $5.00 for each claim over five.

Present costs are: $30.00 on filing, plus $1.00 for each claim over 20, and an equal charge at the time the patent is issued. Comparable increases are made for other Patent Office fees which are set by statute.

During the hearings, it was made clear that better service must be given for the new fees. Rep. Edwin Willis (D., La.), chairman of the group holding the hearings, offered to appear before the appropriations committee with Patent Office witnesses to advocate increased funds for the Office. (All of the fees charged go to the U. S. Treasury; and all Patent Office expenses are paid by Congressional appropriations.)

The American Patent Law Association is opposed to the new increase on the grounds that it would abbreviate the disclosure, making the patent applications more confusing and make more work for the examiner. It amounts to paying a penalty for giving informative background. For example, machinery application claims are many, and need much explanation. Finally, it would stifle the disclosure of inventions, and reduce the number patent applications being filed. A spokesman for the Association is confident that the bill will not be passed.

The committee allowed the Patent Office $14-million for the current fiscal year; this will allow an increase of 300 examiners which is about 50 per cent. These are the men who do the technical patent processing. But actually, this appropriation increase will only pay for 180 examiner-years. Most people feel that about $15.2-million would be needed to pay the salaries and related costs of the 300 examiners over a full year.

How the Patent Office finally got an appropriation of $14-million is a strange story. Congressional Budget Committees are well known for their ability to chisel funds from governmental appropriations requests. With the Patent Office, the Budget Committee "added" $2-million to the Patent Commissioner's request. It seems that the reason he asked for only $12-million was that he said he could not get more examiners. The American Patent Law Association disagreed, and got the Commissioner his examiners. However, he still asked for only $12-million. Congressmen who knew Patent Office operations, recommended the additional $2 million.

Miniature Battery Has Two Year Life

Elgin National Watch Co., Elgin, Ill., in searching for a battery for an electronic wrist watch, has come up with a system which should significantly advance the development of many small personal, industrial, and military devices requiring constant voltage over long periods of time. Secret of the development is the use of Indium as an anode. According to Elgin, it is so successful in eliminating leakage and gassing, that it is possible to place the cell in a thin plastic case, greatly reducing the space usually needed for case purposes. Details on the cathode construction were not released.

The present cell will deliver about 1.15 volts, compared with 1.35 v for most miniature cells; but Elgin says that their cell could be stepped up to 1.37 v by using another cathode material. The present cell, shown in the illustration will operate some miniature military electronic gear at

standard voltage for two years. This is said to be at least 25 per cent more than comparable sealed batteries.

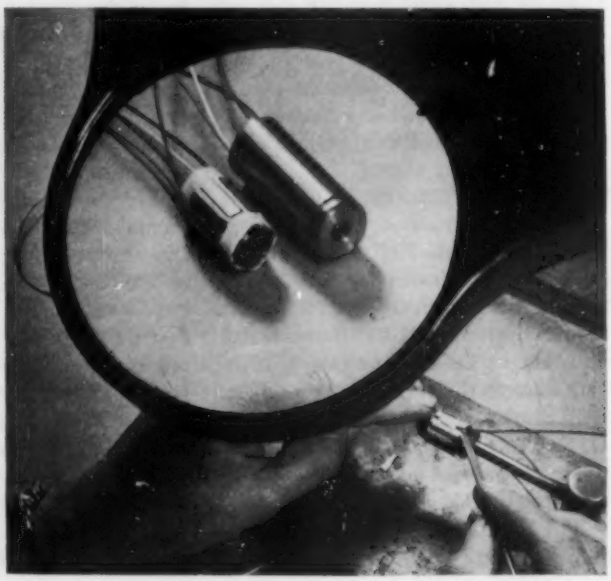
The main disadvantage of mercury cells has been the parasitic reactions taking place during storage and discharge. These reactions result in the formation of gas which often causes battery swelling and electrolytic leakage. Also, these reactions use up the available energy stored in the battery. With the new Indium battery, there is no dimensional during storage or discharge; no deterioration in a temperature range of −20 to 190 F; constant operational characteristics in the range of 0 to 120 F; and the possibility of high current drainage without danger of polarization. The cell can be made almost any size or shape, giving flexibility in product design.

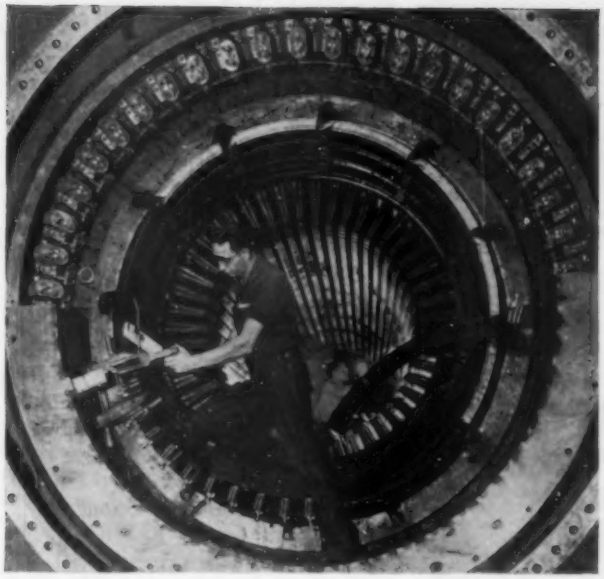
THE NEWS IN PICTURES

A BOEING XB-52 STRATOFORTRESS is making a practice taxi run against a cross wind using a new cross-wind landing gear wheels which roll straight down the runway. Now standard equipment on all production models, all four of the dual-wheel main gear units swivel to either side and are pre-positioned from the control cabin. The 350,000 lb. plane can now use more existing airfields throughout the world by being able to take off or land in a "crabbing" attitude that cancels wind effect across the runway.

OXYCATS, 10,000 of them, are catalytic elements used at Sun Oil Company's refinery to eliminate carbon monoxide and hydrocarbon gases exhausted from a petroleum cat cracker. Burning of these waste gases, which enter at the bottom of the bed, gives a high temperature gas stream that generates 50,000 pounds of steam an hour in a waste-heat boiler above the catalyst bed. In the process the waste gases are cleaned of air pollutants. Made by Oxy-Catalyst, Inc., Wayne, Pa., each oxycat consists of 71 thin porcelain rods suspended between two square porcelain end-plates. A thin catalytic coating on the rods oxidizes the carbon monoxide and hydrocarbon oil vapors with a great release of heat energy. Heat potential will resut in a $200,000 annual fuel saving.

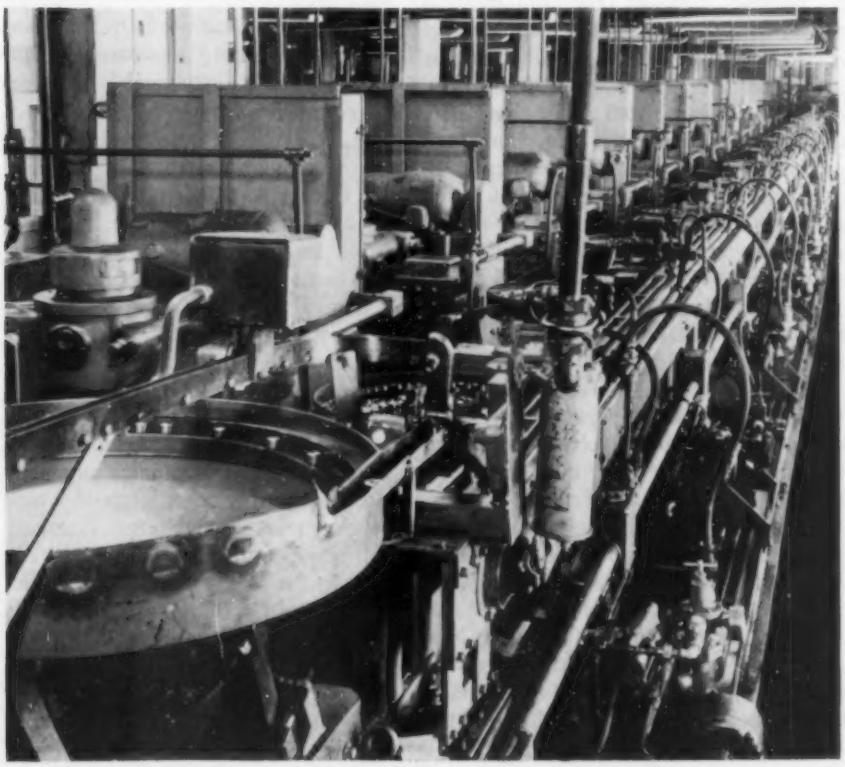
A MAGNIFYING GLASS enlarges two of General Electric's new thumb-sized motors in different stages of completion, while at lower right one is shown in its true size. Manufactured by the Instrument Div. at Lynn, Mass., the motor is $\frac{5}{8}$ in. in dia. and 1.2 in. long, weighs 1.2 ounces, and is rated at 26 volts. Its no-load speed is 21,000 rpm, and is said to have unusually high acceleration, stall torque, and efficiency. This 2-phase, low inertia servo motor was originally designed for use in an aircraft compass-controlled directional gyro-compass system, and will operate in temperatures from —67 to 195 F when used as a control motor, and at altitudes up to 60,000 feet. The motor may be used as a power failure indicator, or as a power-operated brake, as with a gyro compass.





WINDERS ARE SHOWN working on a large generator with a liquid cooled stator which is said to be the first in the history of the electrical industry. The unit, made by General Electric's Large Steam Turbine Generator Plant in Schenectady, N. Y., is rated at 260,000 KVA, and will be installed in the Eastlake power plant of the Cleveland Electric Illuminating Company. Circulating a liquid coolant through the hollow windings in the generator stator will make possible an increase in the capacity of generators without increasing their physical dimensions. The higher capacity will result from a more efficient removal of heat produced. The present method of cooling such large generators is to circulate hydrogen gas through passages in the rotor and stator.

PART OF THE NEW electronic data processing center just opened by International Business Machine Corp. at 590 Madison Ave., New York City. The Center contains a complete lineup of high-speed digital computers and data processing equipment. Included are the IBM 702, 701, and 650, as well as smaller, medium-sized electronic calculators. Shown here is the 702, which was designed to process business and industrial information such as payroll production, inventory control, and all areas of accounting. In the background are eight magnetic tape units which feed and get information from the machine. Over 180 of IBM's large data processing machines have been installed or are on order. Included are the "scientific" 701 and a faster version the 704, and the "business" 702 (above) and a larger and faster model 705. These four types rent for an average of $25,000 per month.



THE 1.5 GEAR SHAPING MACHINES in this production line handle one of the 14 operations on Buick's automatic process line that produces pinion gears for dynaflow transmissions at the rate of 3,000,000 a year. Forty machines are on the conveyorized line to complete the job. Unique addition to the system is an eelctronic device that detects imperfections inaudible to the human ear. Gages check each gear after each machining operation, rejects the part if it is off size, and automatically adjust the machine to make the next gear the proper size. Each gear passes 15 of these inspection stations.

G. E. Opens Metals & Ceramics Laboratory

General Electric's desire for a guaranteed annual growth is typified by the opening last month of their $5-million Metals & Ceramics Lab. in Schenectady, N. Y. But this is just part of the $13-million that G. E. plans to invest in an expansion program for the Research Laboratory at the Knolls. Dr. Hollomon, Manager of the Metallurgy and Ceramics Research Dept. at the Laboratory, feels that the new laboratory will get many problems from the many branches of the company, i.e., the transformer div.; foundry dept.; large steam turbine-generator dept.; gas turbine div.; and the atomic products division.

The equipment in the lab includes an assortment of furnaces with capacities ranging from 4,000 lb. to one pound; a 1250 ton extrusion press; planetary hot and cold-strip mills; swaging machines; hammers; hot slabbing and rod mill; and reversing hot and cold-strip mill. Shown here is the pilot-plant feature of the new building, using full-size erector set structural members which can be put up and quickly altered as a process is developed and perfected. A powders laboratory, part of the building, is concerned mainly with problems of ceramics, but handles metallic powders as well.

The research staff totals about 210, one-half of whom are professional personnel. They will perform basic and applied research in the fields of metallurgy and ceramics, and in the related aspects of physics and chemistry. In addition, it will help to develop and evaluate new materials and processes. Topics of interest in the alloys studies section include: gases in metals; composition and ductility of chromium; polygonization of silicon iron; development of dispersed phases in sintered alloys; creep of pure metals; particle hardening; flow and fracture of ferritic, austenitic, and refractory alloys; origin and nature of residual stresses; domain structures in soft magnetic materials; properties of both soft and permanent magnetic alloys. Work in ceramics will include: single crystals of oxides; sintering; deformation of non-metallic crystals; and the structure and properties of ferro-electrics.

One Week Lecture Series On Titanium

Twenty-two leading scientists and engineers will speak on titanium during a special one-week program of lectures at New York University. Designed for practicing engineers, the lecture series will be given September 12th to 16th at the NYU School of Engineering, and is sponsored by the College's department of metallurgical engineering, the NYU office of Special Services to Business & Industry, and the ASM.

Evening discussion sessions will follow lectures on a variety of subjects. One of the speakers will be Dr. William J. Kroll, inventor of the Kroll process for titanium extraction.

Other speakers will be: Dr. Robert I. Jaffee and Glenn Faulkner, Battelle Memorial Institute; Dr. H. Margolin, Dr. P. Herasymenko, and E. Ence, of NYU; H. Kessler and S. A. Herres, of Titanium Metals Corp.; Dr. D. J. McPherson, and Dr. W. Rostoker, Armour Research; Lee Busch, Mallory Sharon Titanium Co.; M. E. Cieslicki, General Electric; Dr. A. Schwope, Brush Lab.; Dr. L. Jaffe, Calif. Inst. of Tech.; August Bringewald, Republic Aviation Corp.; Sam Tour, of Sam Tour & Co.; Dr. W. Finlay, D. Kaufman, W. Wentz, Rem-Cru Titanium, Inc.; N. E. Promisel, Bureau of Aeronautics, Navy Dept.; and Dr. J. Kahles, Metcut Research Associates.

Europe to Offer Stiff Metals Competition

Dr. George A. Roberts, vice president of the Vanadium-Alloys Steel Co., Latrobe, Pa., and president of the American Society for Metals, returned from a tour of European steel centers with the warning that American industry must work harder to keep up with foreign competition. Dr. Roberts said: "In every part of Europe I saw impressive evidence of modern metalworking and metal-making equipment, along with many other interesting new developments in metallurgy. Germany will be a definite factor in world trade markets for steel products. Every factory in free Germany has been rebuilt from the ground up since World War II, and are steadily adding to a German steel production which has already reached pre-World War II levels."

COMING EVENTS

SEPT. 12-16

Instrument Society of America, Annual Instrument Conferences and Exhibit, Shrine Exposition Hall and Shrine Auditorium, Los Angeles, Calif. Clinics will be held during the Conference. For more information write to: Dr. Arnold O. Beckman, 3443 S. Hill St., Los Angeles, Calif.

SEPT. 12-16

Short Course on Corrosion at the University College and School of Engineering, of Washington University, St. Louis, Mo. In cooperation with National Association of Corrosion Engineers. Topics will be: Corrosion theory, reactions, factors and fundamentals; Metallurgical and mechanical factors; Types of corrosion-diagnosis and treatment; Treatment of the environment; Corrosion testing methods.

SEPT. 14-16

Association for Computing Machinery, Annual Meeting at the University of Pennsylvania, Philadelphia, Pa. Primary effort of the convention will be directed toward bringing the engineer and businessman together to discuss their problems and progress. A series of papers on Linear Programming, Logical and Machine Design, Numerical Analysis, and Business Applications. A series of luncheons and discussion groups is also planned.

SEPT. 14-16

Porcelain Enamel Institute, 17th Annual Shop Practice Forum, Ohio State University, Columbus, Ohio. Program is designed to present information that is directly usable and of practical value to men closely connected with processing operations. Short reports on latest industry developments will include: Coating Thickness Gage for Non-magnetic Metals; Fundamentals of Cathodic Protection; and Solution Ceramics for Enameling; High Temperature Coatings.

SEPT. 19-22

10th Annual Industrial Packaging & Materials Handling Exposition, at the Kingsbridge Armory, New York, N. Y. The Exposition will combine manufacturers' exhibits with short course technical sessions in cooperation with New York University, and a Championship competition for the outstanding achievement in packaging and handling applications.

SEPT. 28-29

Industrial Electronics Conference, Engineering Society at Detroit Auditorium, Detroit, Mich. Conference is cosponsored by the AIEE and the Professional Group of Industrial Electronics of the IRE. Sessions will discuss automation, industrial measurement problems, and new control system applications. A total of 16 papers have been scheduled. Official Convention Headquarters will be the Park Sheraton Hotel. Contact Guido N. Ferrara, 8106 W. Nine Mile Rd., Oak Park, 37, Mich.

OCT. 3-5

National Electronics Conference, Hotel Sherman, Chicago, Ill. The conference is sponsored by the: AIEE; Illinois Institute of Technology; IRE; Northwestern University; and the University of Illinois. Participating are: Michigan State College; Purdue University; University of Michigan; University of Wisconsin; Radio-Electronics-Television Manufacturers Association.

OCT. 5-9

World Plastics Fair & Trade Exposition, National Guard Armory, Los Angeles, Calif. The first comprehensive Plastics Show covering phases of plastics production—reinforced, laminated, formed, extruded, molded, fabricated—to be held on an international scale. Many foreign exhibitors will be in attendance. In line with a plan for "Special Day" promotions, Oct. 5 will be Aviation & Transportation Day; Oct. 6, Electronics, Military and Industrial Day; Oct. 7, Research Development and Engineering Day; Oct. 8, Building & Home Day; Oct. 9, Health & Recreation Day. Plans for the first collective presentation of plastics as used in aircraft are in progress. Parts, components, and applications in seven categories will be included.

OCT. 6-8

11th Annual Meeting and Design Conference of the Society of Industrial Design, Hotel Woodner, 16th St. and Spring Rd., N. W., Washington, D. C. Besides problems of the design of machine tools and other nonconsumer items, the impact of automation on industrial design will be discussed, and the use of market research in determining the size, shape, color of consumer items.

OCT. 10-12

Second Joint Lubrication Conference of the ASLE and ASME, at the Antlers Hotel, Indianapolis, Ind. There will be six sessions covering: bearing instability; recent studies in hydrodynamic lubrication; lubricants; rolling element bearings, and boundary lubrication. A total of 28 papers will be given. More information on the program may be obtained from D. F. Wilcock, General Electric Co., One River Rd., Schenectady, N. Y.

OCT. 17-21

37th National Metal Congress & Exposition, Philadelphia, Pa. Meetings will be held in the headquarter hotels, while the exposition will be held in the convention halls. Over 400 firms will have exhibits. Participating societies are: ASM; American Welding Society; Metals Div., of the American Institute of Mining & Metallurgical Engineers; and the Society for Nondestructive Testing. Some sessions of will be: weldability and research, inspection and testing; stainless steels; welding titanium and molybdenum; pressure vessels and welding aluminum.

OCT. 27-28

11th Annual National Conference on Industrial Hydraulics, LaSalle Hotel, Chicago, Ill. Sponsored by Illinois Institute of Technology, Graduate School, and the Armour Research Foundation, engineering societies and almost 100 industrial organizations. The use of electronic analog computers in the solution of hydraulic problems will be featured. In addition, 9 technical sessions on: automotive applications; fluids; presses; pumps; pneumatics; machine tools, aircraft controls; mobile equipment; and components and accessories.

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for heavy duty jobs

Automatic Electric Class "A" Relays are still "healthy" even after 100,000,000 operations!

Here's a relay built for hard work, and every critical point shows it!

Contact points are formed and life-welded to the spring in one operation. An exclusive armature backstop design prevents armature freezing. A heavy-duty armature bearing is available for unusually heavy spring loads, or constant high-speed use.

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Dimensions

Overall length, 4"—Width, single pile-up 1¼"—double pile-up 1 7/16"—Height (depending upon the number of springs), Series AQA and ASO 1⅝"; Series ASR and ASA 1⅝"-2".

Four different types

Of Class "A" Relays are available to meet your needs: Series AQA—Quick-Acting, DC; Series ASO—Slow-Operating, DC; Series ASR—Slow-Releasing, DC; and Series ASA—Slow-Acting, DC.

Contacts

Normally single, but can be supplied with twin contacts. Load carrying capacity, 150 watts (maximum 3 amps., non-inductive).

Contact spring capacity

Can be supplied with single or double pile-ups. Series AQA and ASO, 13 springs per pile-up; Series ASR and ASA, 6 springs per pile-up. (More contacts can be accommodated at a sacrifice of operating speed and release time delay.)

Design of Double Springs

VICTOR TATARINOV
Pilsen, Czechoslovakia

P_2 — maximum working load, lb
K — factor of safety
KP_2 — breaking load exerted on spring, lb
T — ultimate strength of spring material in torsion, psi
φ — Wahl correction factor for stress
G — Shear Modulus (11,500,000), psi
F — working deflection of spring, in.
P_1 — initial steady load (preloading), lb
D — outside diameter, in.
d — diameter of wire, in.
L — solid height, in.
n — number of active coils
m — number of inactive coils
A_1 — $(D_1/d_1 - 1)^3/143.75$
A_2 — $(D_2/d_2 - 1)^3/143.75$
(Prime values (′) refer to outer spring
Double prime (″) refers to inner spring

ALTHOUGH double helical springs are often useful—for example, as a means of reducing the length of spring for a given capacity—they are rather tedious to design. The procedure can be simplified considerably with the data in Table I. Essentially, this table represents the solutions to 40 different initial conditions, and includes data for both single and double helical springs. Thus, not only are calculations simplified, but also the merits of utilizing a double spring can be quickly established.

The data for double springs is based upon the maximum working load P_2 that is established for a single spring, preloading force P_1, spring dia D and the working deflection F. The wire dia d is calculated from the equation

$$KP_2 = \frac{Td^3}{2.55\ (D - d)\ \varphi} \tag{1}$$

Number of active coils is calculated from

$$n = \frac{Gd^4F}{8\ (P_2 - P_1)\ (D - d)^3} \tag{2}$$

Assuming that the solid height and the preloaded heights of both springs in the double spring combination are equal, the fundamental design equation is

$$(n_1 + m_1 - 0.5)\ d_1 = (n_2 + m_2 - 0.5)\ d_2 \tag{3}$$

where

$$n_1 = \frac{10{,}000\ Fd_1}{(P_2' - P_1')\ A_1} \tag{4}$$

$$n_2 = \frac{10{,}000\ Fd_2}{(P_2'' - P_1'')\ A_2} \tag{4a}$$

A_1 and A_2 are defined at left, and the number of inactive end coils m is 2 for n values from 5 to 10 inclusive, and 2.5 for n larger than 10.

EXAMPLE

Given: $P_2 = 1{,}800$ lb, $P_1 = 1{,}000$ lb, $K = 3.5$ and $F = 1.0$ in.

Thus, $KP_2 = 6{,}300$ lb and $(P_2 - P_1) = 800$ lb.

Single Spring

In Table I, the solution with a value of KP_2 that is closest to 6,300 is No. 20. From this, the dimensions of the single spring are:

$D = 3\ 1/2$ in., $d = 11/16$ in., and $A = 0.48$

From Eq (4)

$$n = \frac{(10{,}000)\ (1.0)\ (11/16)}{(800)\ (0.48)} = 18$$

The solid height of the single spring would be

$$L_0 = (18 + 2.5 - 0.5)\ (11/16) = 13.75 \text{ in.}$$

Double Springs

Also from Table I, the data for the outer spring of a a double design are: $D_1 = 3\frac{1}{4}$ in., $K = 3.5$, $KP_2' = 5{,}000$ lb, $P_2' = 5{,}000/3.5 = 1{,}428$ lb, $d_1 = \frac{5}{8}$ in., and $A_1 = 0.68$.

For the inner spring: $D_2 = 1\frac{7}{8}$ in., $KP_2'' = 1{,}270$ lb, $P_2'' = 363$ lb, $d_2 = 0.3065$ and $A_2 = 0.93$. The unknown values, P_1' and P_1'', are related as follows:

$$P_1' + P_1'' = 1{,}000$$

The solid height of the double spring, which cannot be solved directly, is:

$$L_0 = (n_1 + m_1 - 0.5)\ d_1 = (n_2 + m_2 - 0.5)\ d_2$$

One method of solving this equation is to plot curves for L' and L'', the solid height of the inner and outer spring,

(continued on page 211)

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. . . You'll Save Money!

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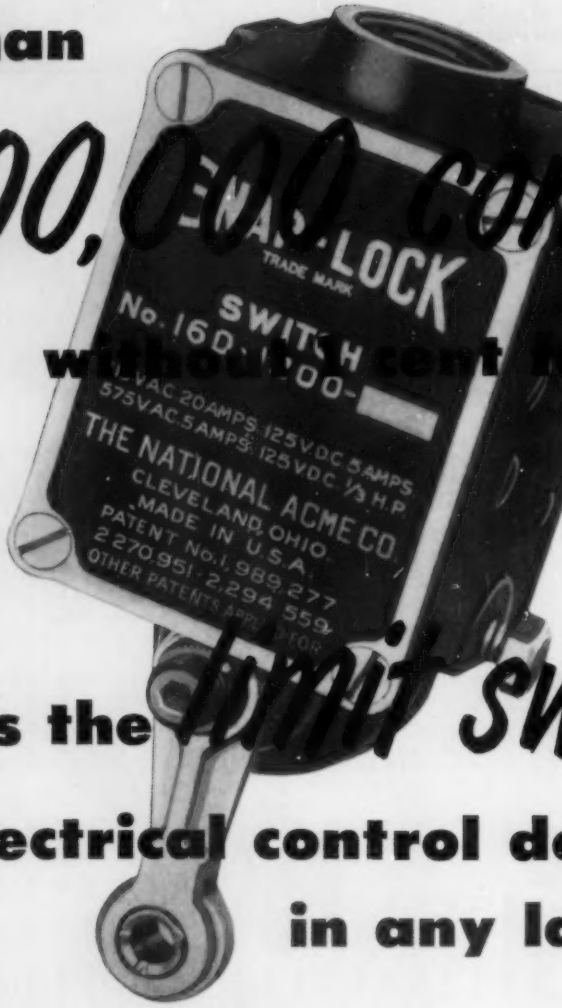
Table I—Tabulated Solutions of Single and Double Helical Springs

Design of Double Springs (continued from page 209)

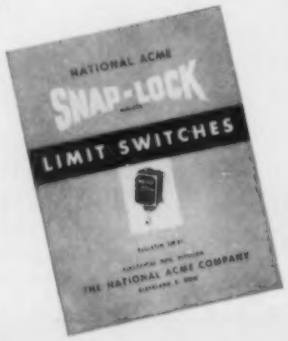
	P_2	KP_2	D	d	P_1	P_2-P_1	D/d	A	F	n	m	Lo	D_1	d_1	KP_2'	P_2'	P_1'	$P_2'-P_1'$	D_1/d_1	A_1	F	n_1	L	D_2	d_2	n_2	D_2/d_2	A_2	$P_2''-P_1''$	KP_2''	P_2''	P_1''
1	89	267	1½	0.162	15.6	73.4	9.28	3.95	1½	8.5	2	1.62	1½	0.135	155	51.7	11.7	40	11.12	7.21	1½	7	1.15	1⅛	0.1055	9	10.1	5.24	33.4	112	37.3	3.9
2	106	318	1½	0.177	13.7	92.3	8.48	2.90	1½	10	2½	2.12	1½	0.1483	200	66.7	9.7	57	10.08	5.2	1½	7.5	1.33	1	0.1055	10.5	9.5	4.27	35.3	118	39.3	4.0
3	124.3	373	1½	0.192	17.7	106.6	7.82	2.25	1½	12	2½	2.69	1½	0.162	255	85	8	77	9.28	3.95	1½	8	1.54	1	0.1055	12.5	9.5	4.27	29.6	118	39.3	9.7
4	147.7	443	1¾	0.207	14.8	132.9	8.44	2.88	2	11	2½	2.69	1¾	0.177	290	96.7	11.9	84.8	9.9	4.9	2	8.5	1.77	1⅛	0.1205	12.5	9.33	4.02	48.0	153	51.0	3.0
5	168.3	505	1¾	0.225	29.8	138.5	7.77	2.16	2	15	2½	3.83	1¾	0.192	352	117.3	14.1	103.2	9.12	3.72	2	10	2.31	1⅛	0.1205	17	9.33	4.02	35.3	153	51.0	15.7
6	220	660	1¾	0.244	35.2	184.8	7.18	1.65	2	16	2½	4.38	1¾	0.207	450	150	20	130.0	8.45	2.88	2	11	2.70	1⅛	0.135	18	8.33	2.74	54.8	210	70.0	15.2
7	253.3	760	1¾	0.244	32.6	220.7	7.18	1.65	2	13.5	2½	3.77	1¾	0.2855	550	183.3	8.5	174.8	7.76	2.15	2	12	3.16	1⅛	0.135	21.5	8.33	2.74	45.9	210	70.0	24.1
8	288.3	865	2	0.283	27.5	260.8	7.075	1.56	2	14	2½	4.53	2	0.2437	630	210	14	196.0	8.22	2.62	2	9.5	2.68	1¼	0.1483	16	8.43	2.86	64.8	235	78.3	13.5
9	343.3	1030	2	0.283	43.5	299.8	7.075	1.56	2	12	2½	3.96	2	0.2625	795	265	17	248.0	7.62	2.02	2	10.5	3.29	1¼	0.1483	20	8.43	2.86	51.8	235	78.3	26.5
10	426	1278	2	0.306	55.0	371.0	6.53	1.18	2	14	2½	4.9	2	0.283	970	323.3	20.3	203.0	7.07	1.55	2	12	3.97	1¼	0.162	22.5	7.72	2.11	68.0	308	102.7	34.7
11	515	1545	2	0.331	46.3	468.7	6.05	0.9	2	15.5	2½	5.8	2	0.3065	1200	400	12	388.0	6.52	1.17	2	13.5	4.75	1⅛	0.162	27.5	6.94	1.46	80.7	345	115.0	34.3
12	590	1770	2¼	0.362	44.5	545.5	6.21	0.99	2	14	2½	5.8	2¼	0.331	1370	456.7	12.7	444.0	6.80	1.36	2	11	4.32	1¼	0.177	22.5	7.06	1.55	101.5	400	133.3	31.8
13	700	2100	2¼	0.394	80.5	619.5	5.71	0.731	2	17.5	2½	7.68	2¼	0.362	1700	566.7	24.7	542.0	6.22	0.99	2	13.5	5.62	1¼	0.177	29.5	7.06	1.55	77.5	400	133.3	55.8
14	804	2410	2½	0.43	95.2	708.1	5.81	0.78	2	15.5	2½	7.53	2½	0.394	2000	666.7	24.2	642.5	6.35	1.06	2	11.5	5.33	1½	0.192	25.5	7.82	2.21	65.7	410	136.7	71.0
15	1015	3045	2½	0.461	88.8	926.2	5.42	0.601	2	16.5	2½	8.51	2½	0.43	2500	833.3	18.3	815.0	5.82	0.78	2	13.5	6.52	1⅜	0.207	29.5	6.65	1.25	111.7	545	181.7	70.0
16	1222	3666	2½	0.49	93.6	1128.4	5.09	0.651	2	19	2½	10.28	2½	0.461	3006	1002	16	986	5.42	0.60	2	15.5	8.07	1⅜	0.2255	34	6.11	0.93	142.4	650	220.0	77.6
17	1483	4450	2½	5/16	90.3	1393	4.43	0.28	2	29	2½	17.5	2½	0.49	3510	1170	38	1132	5.10	0.48	2	18	9.80	1¼	0.2437	38	5.14	0.49	261.0	940	313.3	52.3
18	1373	4120	3	5/16	156.3	1217	5.34	0.561	2½	20	2½	12.36	3	½	3000	1000	42	958	6.0	0.87	2½	15	8.50	1¾	0.283	28	6.2	0.98	259.0	1120	373.3	114.3
19	1780	5340	3	⅝	101.7	1678	4.8	0.382	2½	24.5	2½	16.56	3	5/16	4120	1373	23	1350	5.34	0.56	2½	18.5	11.56	1½	0.283	39	5.3	0.553	328	1220	406.7	78.7
20	2090	6270	3½	11/16	177.3	1913	5.1	0.48	2½	19	2½	14.45	3½	⅝	5000	1667	25	1642	5.6	0.68	2½	14	10.0	1⅞	0.3065	30.5	6.11	0.93	271	1270	423.3	152.3
21	2627	7880	3½	¾	261	2366	4.67	0.341	2½	23	2½	18.75	3½	11/16	6270	2090	30	2060	5.09	0.48	2½	17.5	13.38	1⅞	0.331	38.5	5.66	0.7	306	1610	537.3	231.0
22	2957	8870	4	11/16	342	2615	4.88	0.41	3	23	2½	20.3	4	¾	7050	2350	85	2265	5.33	0.57	3	17.5	14.62	2⅛	0.362	38.5	5.87	0.8	350	1820	607	257
23	3550	10650	4¼	⅞	378	3172	4.85	0.40	3	21	2½	20.15	4¼	11/16	8600	2867	67	2809	5.23	0.53	3	16.5	15.04	2⅛	0.394	36	6.02	0.88	372	2050	683	311
24	4166	12500	4½	11/16	457	3709	4.8	0.38	3	20	2½	20.65	4½	⅞	10000	3333	87	3246	5.13	0.49	3	16.5	16.2	2½	0.43	36	5.81	0.77	463	2500	833	370
25	4843	14530	4¾	1	556	4287	4.75	0.37	3	19	2½	21.0	4¾	11/16	11500	3833	93	3740	5.07	0.47	3	16	16.9	2½	0.461	35	5.42	0.6	547	3030	1010	463
26	5533	16600	5	1⅛	480	5053	4.46	0.291	3	23	2½	28.1	5	1	13000	4333	108	4225	5.0	0.44	3	16	18.0	2⅝	0.5	34	5.25	0.53	828	3600	1200	372
27	6100	18300	5½	1⅛	537	5563	4.64	0.335	3	19	2½	24.9	5½	1⅛	14100	4700	200	4500	5.18	0.50	3	14	17	3	5/16	28	5.33	0.57	1063	4200	1400	337
28	6820	20460	5½	1¼	644	6176	4.4	0.27	3	22	2½	30.0	5½	1⅛	16200	5400	250	5150	4.89	0.41	3	16	20.26	2⅞	5/16	34	5.11	0.48	1026	4260	1420	394
29	7783	23350	6	1⅛	738	7045	4.57	0.315	3	23.5	2½	33.4	6	1⅛	18000	6000	300	5700	5.05	0.46	4	18	23.8	3¼	⅝	36	5.2	0.52	1345	5350	1783	438
30	6583	19750	6¼	1¼	508	6075	5	0.45	3	14	2½	20.0	6¼	1⅛	14900	4967	92	4875	5.56	0.66	3	10.5	14.05	3⅛	⅝	20.5	5.79	0.76	1209	4850	1617	417
31	7533	22600	6½	1⅜	473	7060	4.73	0.36	3	16	2½	24.8	6½	1⅝	16600	5533	183	5350	5.5	0.63	3	10.5	14.85	3¾	11/16	19.5	5.46	0.62	1710	6000	2000	290
32	8833	26500	6¾	1⅞	455	8378	4.70	0.352	4	14.5	2½	23.8	6¾	1¼	19000	6333	308	6025	5.4	0.59	3	10.5	15.65	3⅞	¾	19	5.16	0.5	2353	7500	2500	147
33	9233	27700	7	1½	533	8700	4.67	0.341	4	20	2½	33.0	7	1⅝	20700	6900	240	6660	5.32	0.56	4	14	21.0	4	¾	26	5.33	0.56	2040	7000	2333	293
34	10633	31900	7¼	1⅞	573	10060	4.63	0.333	4	18.5	2½	32.0	7¼	1⅜	23400	7800	300	7500	5.27	0.54	4	13.5	21.3	4¼	11/16	24	5.24	0.53	2560	8500	2833	273
35	11366	34100	7½	1⅝	799	10567	4.62	0.331	4	18.5	2½	33.3	7½	1⅜	25600	8533	403	8130	5.22	0.52	4	13.5	22.3	4¼	11/16	25.5	5.22	0.52	2437	8500	2833	396
36	12140	36420	7¾	1 11/16	530	11610	4.49	0.296	4	19.5	2½	36.2	7¾	1½	27920	9307	427	8880	5.16	0.5	4	13.5	23.3	4¼	⅞	24.5	5.22	0.52	2730	8500	2833	103
37	13167	39500	8	1¾	684	12483	4.57	0.316	4	17.5	2½	34.1	8	1⅞	30500	10167	292	9875	5.12	0.49	4	13	23.4	4⅜	11/16	25.5	5.18	0.51	2698	9000	3000	392
38	14133	42400	8¼	1 11/16	804	13329	4.55	0.311	4	17.5	2½	35.3	8¼	1⅝	32900	10967	357	10610	5.07	0.47	4	13	24.4	4½	⅞	26	5.14	0.49	2720	9509	3167	447
39	15533	46600	8½	1⅞	951	14580	4.53	0.308	4	17	2½	35.0	8½	1 11/16	35500	11833	483	11350	5.03	0.46	4	13	25.3	4¾	11/16	25	5.06	0.46	3232	11100	3700	468
40	17400	52200	8¾	2	578	16822	4.37	0.268	4	18	2½	40.0	8¾	1¾	38500	12833	233	12600	5	0.45	4	12.5	25.4	4⅞	1	23.5	4.87	0.4	4222	13700	4567	345

(continued on page 213)

more than 15,000,000 contacts without cent for repairs...



here's the limit switch that spells electrical control dependability in any language



Send for Bulletin EM-51 which shows various types of Snap-Lock Limit Switches available, design features, specifications, wiring diagrams, ordering data—and other National Acme electrical components and controls.

Proven stamina under all kinds of operating requirements (some installations requiring more than 400 contacts per minute) has made National Acme SNAP-LOCK Limit Switches a top-heavy favorite with both design and production engineers.

Mechanical simplicity and ruggedness are the reasons why Snap-Locks have proven an outstanding success in thousands of heavy duty equipment installations. The record shows that in many such cases, they have stood up under more than 15,000,000 contacts.

Built in a variety of sizes and designs including water resistant and special purpose types.

Ask us to assist you in designing these trouble-free switches into your equipment

ELECTRICAL MANUFACTURING DIVISION

The NATIONAL ACME COMPANY

170 EAST 131st STREET • CLEVELAND 8, OHIO

Design of Double Springs (continued from page 211)

Table II—Solid Height Data for Numerical Example

INNER SPRING						OUTER SPRING				
e_2	P_1'', lb	$(P_2''-P_1'')$, lb	n_2	n_2+2	L_2, in.	P_1', lb	$(P_2'-P_1')$	n_1	n_1+2	L_1, in.
50	181.5	181.5	18.2	20.2	6.20	818.5	609.5	15.1	17.1	10.7
60	218	145	22.7	24.7	7.58	782	646	14.2	16.2	10.1
70	254	109	30.3	32.3	9.92	746	682	13.5	15.5	9.68
SOLUTION										
69.5	253	110	30	32	9.72	747	681	13.6	15.6	9.72

respectively, as a function of the ratio P_1''/P_2''. The equations to be used for plotting these curves are:

$$n_2 = \left(\frac{10{,}000\,Fd_2}{A_2}\right)\left(\frac{1}{P_2'' - P_1''}\right) \text{ and}$$

$$n_1 = \left(\frac{10{,}000\,Fd_1}{A_1}\right)\left(\frac{1}{P_2' - P_1'}\right)$$

Table II gives the results of calculating L' and L'' for different values of $e_2 = P_1''/P_2''$. These values, plotted at right, indicate a solution at $e_2 = 69.5$, for which $L = 9.72$.

This suggests that the use of double springs will result in a reduction of $13.75 - 9.72 = 4.03$ in. in solid height. However, it is never possible to compress all coils solids. Taking the clearance between adjacent coils on the inner springs as 1/32 in.,

$$L = 9.72 + (1/32)\,(30) = 10.66 \text{ in.}$$

Free height of inner spring,

$$L_f'' = 10.66 + \frac{P_2''}{P_2'' - P_1''} \times F = 14.1 \text{ in.}$$

Free height of outer spring,

$$L_f' = 10.66 + \frac{P_2'}{P_2' - P_1'} \times F = 12.8 \text{ in.}$$

To compare the above results with a design using rectangular wire, the method and data given in *Product Engineering*, November 1953, page 207 (also see *Annual Handbook of Product Design* for 1955, page F-37) can be used. The results are:

t = 0.473 in.
b = 0.946 in.
L = 11.8 in. (corrected for trapezoidal error)
N = 20 active coils
Weight 22.2 lb

Shown in Table III is a comparison of the single, double and rectangular wire springs. See *Product Engineering*, June 1955, page 143 for a list of other recent articles on time-saving spring design procedures.

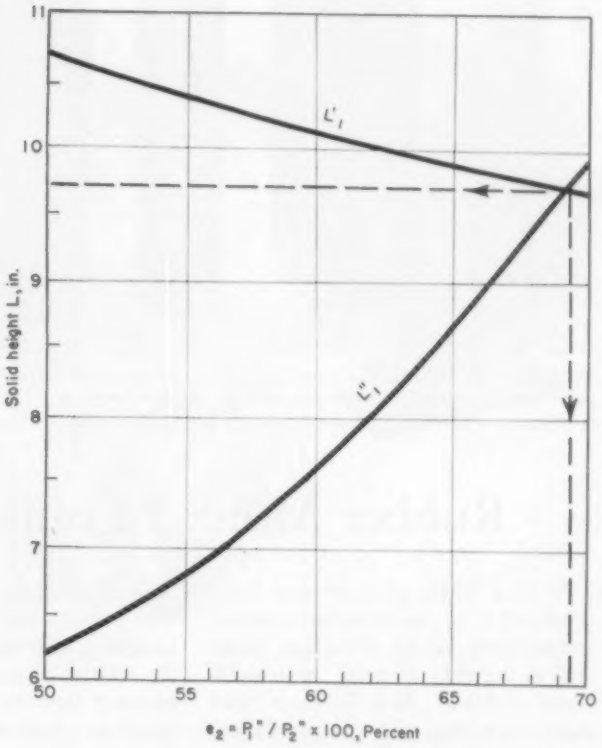
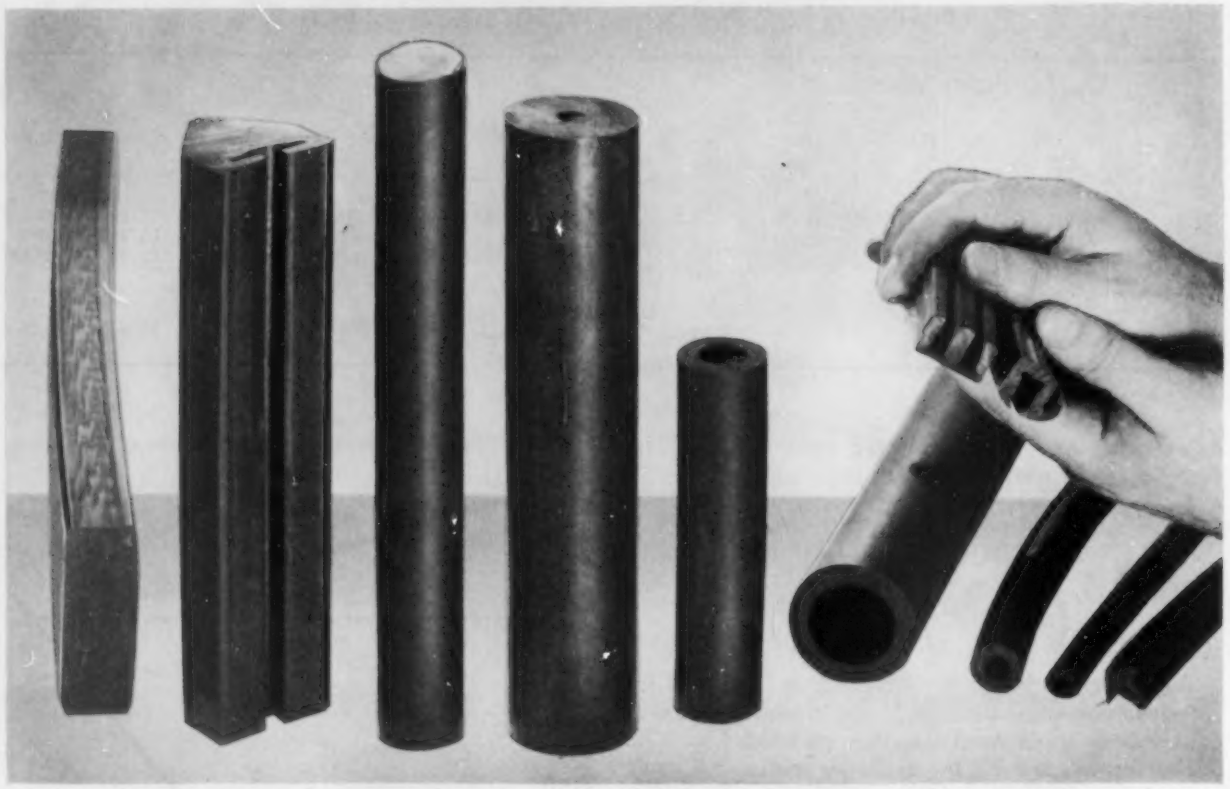


Table III—Comparison of Single, Double and Rectangular Springs

Type	Wire size, in.	Solid height, n.	Weight, lb
Single.....	d = 11/16	13.75	18.5
Double.....	d_1 = 5/8 d_2 = 0.3065	9.7	15.4
Rectangular... (single)	0.473 x 0.946	11.8	22.2



MOLDED RUBBER PARTS made by a new process called continuous molding are shown in a variety of shapes and sizes. The parts can be produced in any practical length, compared to a limit measured in feet for conventional molding. Practically all scrap is eliminated and labor costs of splicing are sharply reduced because the exact lengths required can be cut as needed.

Rubber Molded Continuously to Any Length

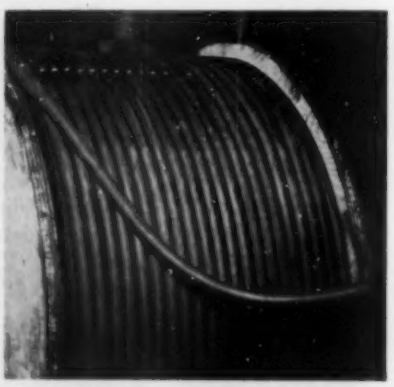
Molded rubber parts are now being produced by a process called continuous molding, which is cheaper, faster and as accurate as press, or conventional molding. It is far more exact than extruding, and can use lower durometer or much softer rubber stocks. This is important where springiness or compression fit is necessary.

In the rubber extrusion process, no molding pressure or curing period occurs after material has left the die. In the new continuous molding equipment, pressure is applied and curing affected while the rubber is still in the machine.

Biggest advantage over press curing is the unlimited lengths in which continuously molded parts can be made with close dimensional tolerances. Length is limited only by the size of the reel to be shipped. There is no inherent limitation on the cross sectional area that can be molded either. Customers can cut to the exact lengths needed, eliminating practically all scrap and reducing the cost of parts.

Currently in production are seals for concrete pressure pipe, forms for concrete slabs and engine mountings. Seals for double windows, sink spray hose and windshield wiper tubing are being tested. Both natural and synthetic rubber can be molded in this new process.

Only one splice per window was found necessary by one window manu-



A CONTINUOUS REEL of thousands of feet of molded rubber gasket for concrete pipe. In this application, one of the first, only one splice is necessary for any size concrete pipe, eliminating scrap and cutting splicing cost.

facturer who tested the continuously molded double window seal in long lengths. He pointed to obvious savings in time and money when contrasted with the many splices of 6-ft, press-cured lengths he has been using.

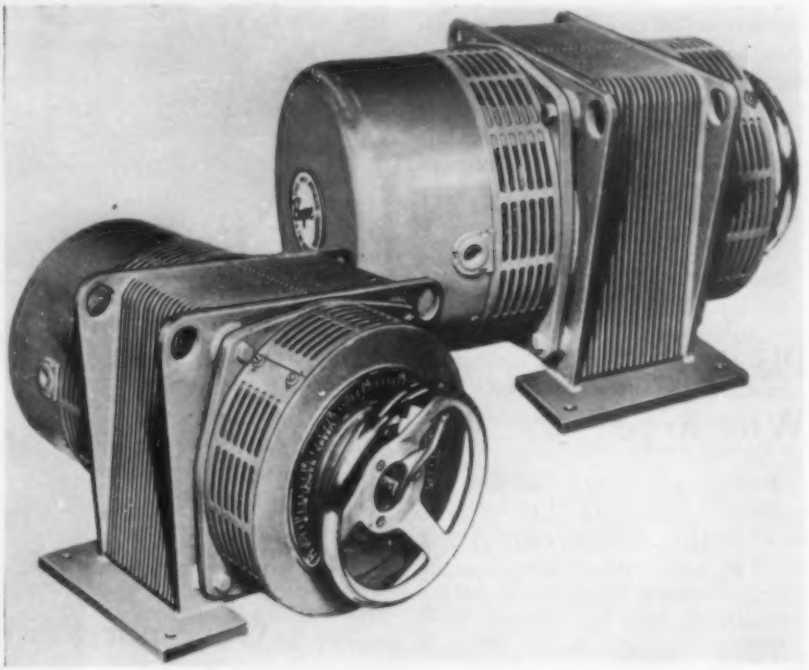
The new molding process is expected to help concrete pipe manufacturers who have found extruded rubber gaskets too hard and not accurate enough. The hard stock required for extruding often causes concrete pipe to break when assembled. Soft rubber stock of continuously cured gaskets assures accurate fit, faster assembly and minimizes breakage.

Except for the wider range of durometer ratings possible with this continuous molding process, other properties and characteristics of both natural and synthetic rubber remain the same as regularly molded material. U. S. Rubber Co., Rockefeller Center, New York 20, N. Y.

For more information—
Circle 1, inside back cover

Variable Speed A-c Motor

A type of variable speed a-c motor now being manufactured in the United States for the first time is reported to be adjustable over a wide range of speed under all loading conditions, without brush movement. Its stator is that of a normal induction motor and is connected to the supply, which may be low or high voltage. If it is high voltage, the usual limits applying to induction motors of the same output apply. The rotor is similar to the armature of a d-c motor with the addition of auxiliary winding. Speed variation is obtained by means of a simple induction regulator.



When the stator is energized, a rotating magnetic field is set up, and under the influence of this field the rotor will revolve in one direction. The frequency and magnitude of the voltage induced in the rotor decrease as the rotor speed increases, until at synchronous speed both are zero. When the rotor winding is connected to a commutator, the frequency of the voltage appearing at the brushes will be constant and equal to the supply frequency. The voltage will vary with the speed.

When the induction regulator is adjusted so that its voltage opposes the rotor voltage, the speed of rotation is reduced until the commutator voltage balances the regulator voltages. By further adjusting the induction regulator, this voltage may be built up in the opposite direction. In this way, motor speeds above synchronous speed can be obtained. Balance between the rotor voltage and the reversed regulator voltage occurs at super-synchronized speed.

The induction regulator effects an exchange of energy between the rotor of the new motor and the supply. At low speeds, power is taken from the rotor and returned to the supply, and at speeds above synchronism, power is taken from the supply and fed to the rotor. This energy transfer or power saving is equal to the amount which would ordinarily be wasted in the usual external resistance, if the same speed reduction was obtained by rotor resistance regulation as used in a slip-ring induction motor.

This motor normally has a shunt speed characteristic, that is, the speed fails somewhat with increase in load unless speed is regulated. When accurately controlled constant speed is required at any setting, it can be provided as necessary. The shape of the inherent torque-speed characteristic varies only slightly at various regulator positions.

Manual control is effected by a

CONTINUED ON PAGE 216

hand wheel on the regulator. This alters the position of the regulator rotor, varying the speed of the motor between the design limits. The regulator can be placed at any remote location within easy reach of the operator.

Hand-operated regulators are provided with a graduated scale and pointer to indicate the speed setting. The motor may also be provided with a tachometer for speed indication. Ratings available range from 0.5 to 1000 hp. The new drive is designed to operate on three-phase a-c power of 50, 60 or 400 cps.

In this motor's remote speed control system the position of the regulator is adjusted by means of a small pilot motor. One or more push-button stations or other switching elements may be provided at convenient positions on or near the driven machine or central control station. Automatic speed control can be provided for any type of driven machine or process. Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson, N. J.

For more information—
Circle 2, inside back cover

Plastic Coated Wire Rope

A plastic coated cable has been announced, available in 1/16 in. wire rope size ($\frac{1}{8}$ in. dia with coating) to $\frac{1}{4}$ in. ($\frac{3}{8}$ in. with coating), in transparent green, or opaque white. Strengths are 480 to 7000 lb.

This new cable is either a preformed galvanized steel or stainless steel wire rope, coated with flexible plastic. The thickness of the plastic coating varies with the diameter of the rope.

The flexibility of the rope is not adversely affected by the plastic coating. It resists sunlight, oxidation, and is said to provide excellent color stability. It is resistant to most acids, bases, salts, oils and greases, except hydrofluoric acid and methyl ethyl ketone. Macwhyte Co., 2940-14 Ave., Kenosha, Wis.

For more information—
Circle 3, inside back cover

Governor With Interchangeable Weight Systems in Same Body

The weight systems in this governor are interchangeable in the same body to meet the regulation and cost requirements of each application. Each weight system is designed to cover a specific regulation requirement.

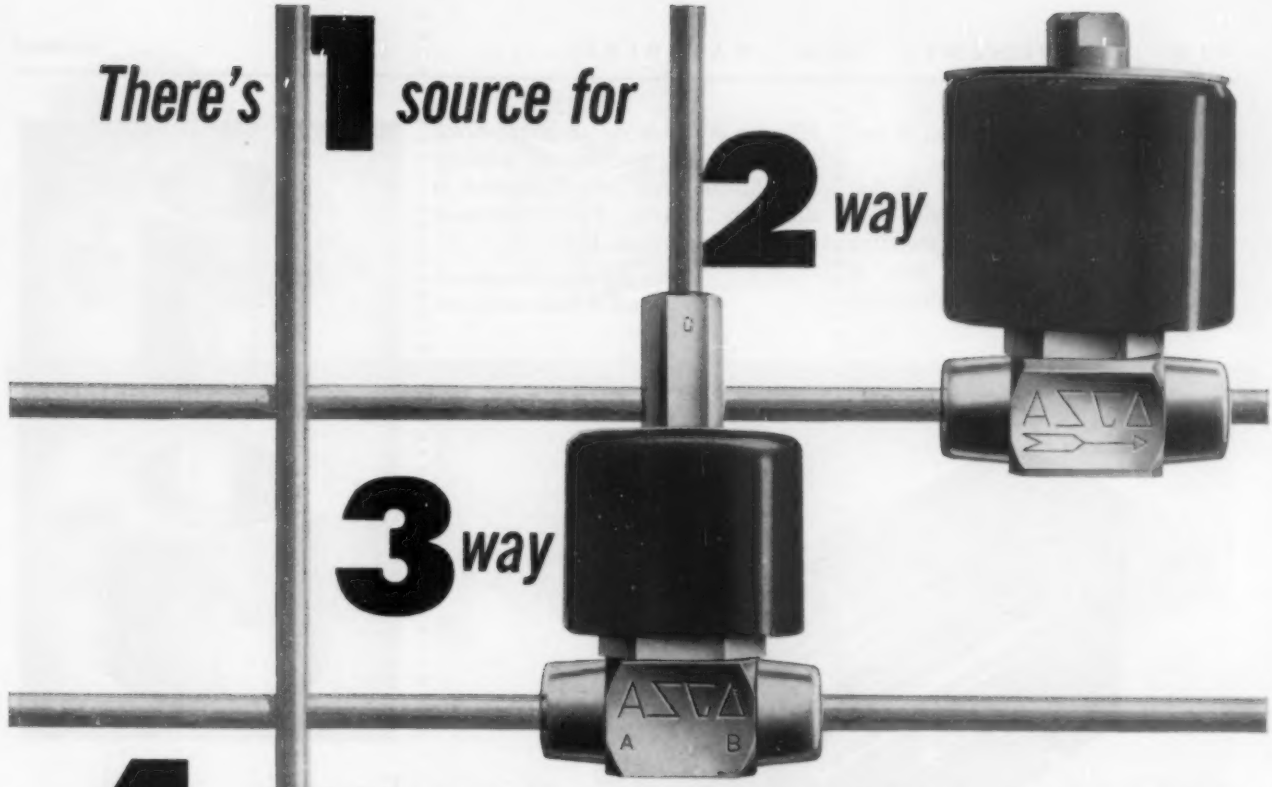
The "cam nose" weight system gives 5 to 10 per cent regulation and is said to be suitable for farm tractors, combines and similar applications where low cost and long wear is important. A "hinge" system delivers 3 to 5 per cent regulation, for applications such as welders and combines.

The "laminated" weight system is for precision governing where 3 per cent or better regulation is required. It is recommended for generators, welders and similar applications where extremely close governing is a must. Meets all government specifications for performance and life.

For the manufacturer with an assortment of products having a range of governing requirements, the same basic governor installation can be

CONTINUED ON PAGE 218

There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

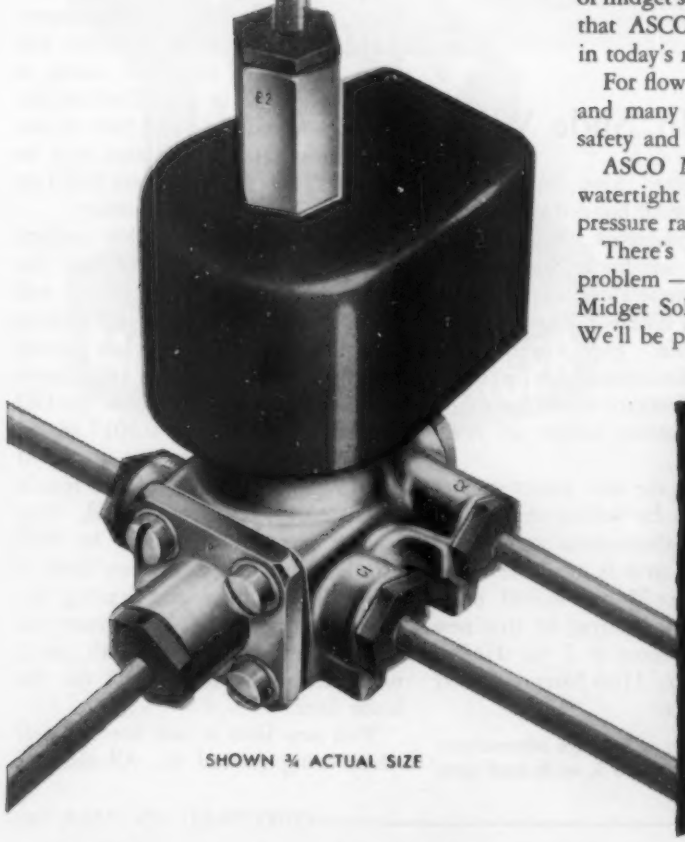


Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes ⅛" and ¼"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem — ASCO. Write today for complete data on ASCO Midget Solenoid Valves — or outline any of your requirements. We'll be pleased to assist you.



SHOWN ¾ ACTUAL SIZE

ASCO®
Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves
Automatic Switch Co.

made on all engines regardless of end use.

The governor is universal in that levers for both constant speed and long range models may be mounted on either the right or left side. A broken throttle lever for simplified idling is available on all installations. Expensive and troublesome telescoping throttle rods are eliminated in this new control. Pierce Governor Co., Inc., Anderson, Ind.

For more information—
Circle 4, inside back cover

Tape Potentiometer With 144-In. Slide Wire

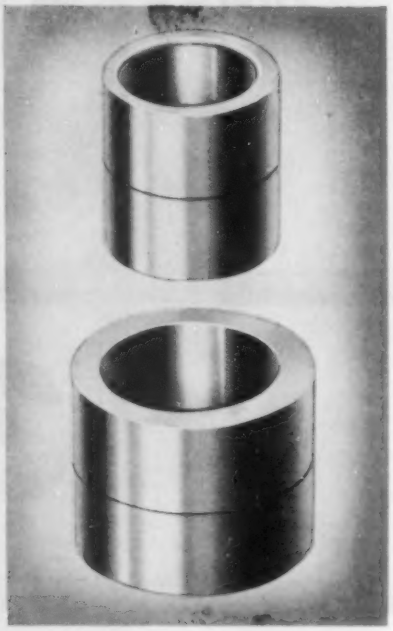
This manually operated, direct reading potentiometer for precision laboratory, commercial and industrial applications has a 144-in. laboratory type straight slide-wire with direct calibration. It is furnished in a package for use in apparatus and assemblies such as precision bridges and electronic equipment.

For direct calibration, in terms of either linear or non-linear functions of a straight slide-wire, the new unit is said to eliminate a source of error always present when non-linear functions must be converted into potentiometer readings. Direct reading, in digits, it is not subject to human error in interpreting scale readings; it permits the use of inexperienced personnel and simplifies equipment operation.

This potentiometer consists of a white vulcanized fibre tape with a resistance element bonded to the edge. The unit is calibrated, after assembly, in linear or non-linear terms as required. Temperature curves corresponding to different type thermocouples, strain gage calibrations, resistance bulb calibrations, or direct readings in resistance values are examples of calibrations which are available.

Accuracy of the new potentiometer is reported to be within ± 0.1 per cent. Overall dimensions are $4\frac{7}{8}$ x 3 x $2\frac{1}{4}$ in. The unit is available in resistances from 75 to 30,000 ohm. Power dissipation rating of this new tape potentiometer is 2 w. Howell Instrument Co., 1106 Norwood, Fort Worth 7, Texas.

For more information—
Circle 5, inside back cover



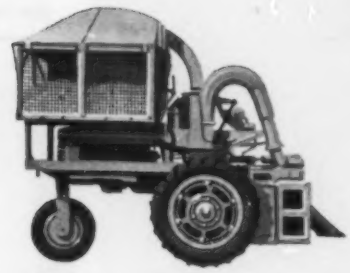
Eccentric, Interlocking Hole Liners

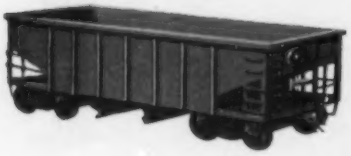
An adjustable, interlocking hole liner consisting of two mated eccentric parts, each an 0.032 in. eccentric, will allow movement of a hole center as much as 0.062 in any direction desired. With a slip fit of 0.0003 in. for positioning, the hole center may be moved in two directions—say 0.010 in. one way and 0.020 in. another.

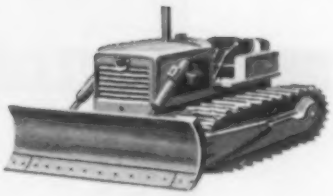
After the hole center has reached the desired tolerance, pressing the liners together with the fingers will cause them to lock. After re-checking tolerance, the liner halves are pressed completely together on an arbor press. With a step of 0.0015 in. on the OD of the male, a step of 0.0015 in. on the ID of the female and a step of 0.0015 in. on the OD of the female when completely compressed, they have a press fit equivalent to 4000 psi. By hardening the inner liner to 62-64 Rc hardness and leaving the outer liner soft, the outer liner will expand into the plate. This minimizes collapsing of the ID on the inner liner.

This new liner is said not to spiral when being pressed in. All sizes of

CONTINUED ON PAGE 220







MAKE IT WEIGH LESS

N-A-X

HIGH-TENSILE STEEL

MAKE IT LAST LONGER

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

the liner will accommodate all ASA slip removable bushings. Standard ASA bushing tolerances are held.

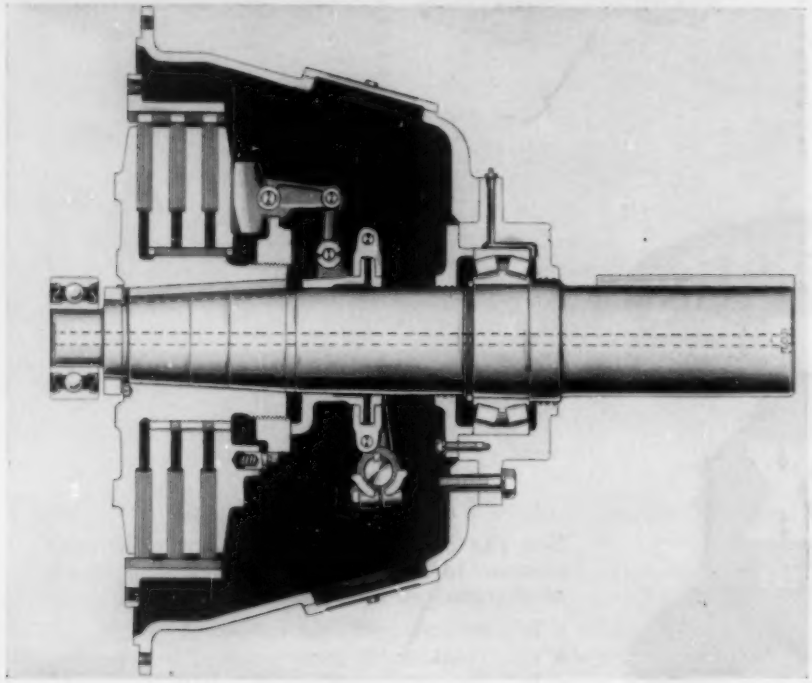
Tool steel of the same type used by bushing manufacturers is normally used. However, the new parts may be made out of any material desired.

These lines may be pressed out and relocated, but after two or three times, the OD of the female becomes rough and positioning becomes difficult.

All OD's of the female liner are standard reamer sizes. Drill sizes 0.098 to 1.000 in. are manufactured. Delivery on some sizes are immediate. Those that are not in stock require six to seven days. Lee Liner Co., 107 Sierra St., El Segundo, Calif.

For more information—
Circle 6, inside back cover

MECHANICAL COMPONENTS



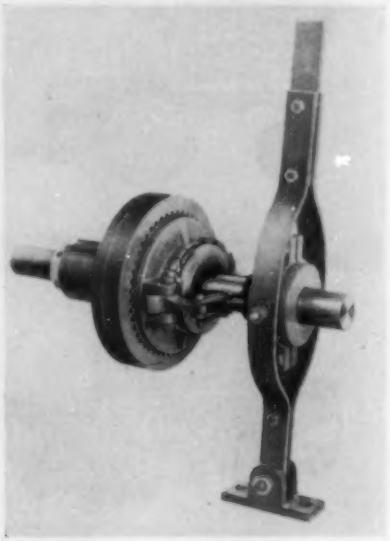
Friction Power Take-Off

This power take-off was designed to meet the requirements of engines in the 350 to 375 hp class, operating in the 1800 rpm range. It accommodates an SAE No. 0 flywheel. With triple drive-plate construction, ample friction surfaces to withstand excessive heat is said to be assured. And with the solid driving plate design, the new unit can effectively handle the stress of higher rpm.

The pilot bearing of this power take-off is composed of a single row of balls, operating in bearing races of doublerow width. Pilot bearings of this type provide additional space for lubricant, which is more effectively retained by the double grease shield construction. The clutch shaft is drilled to provide for relubrication of the pilot bearing in the conventional manner.

At present, the SP-314 is available for engines in the 225 hp range operating at 2200 rpm. Twin Disc Clutch Co., Racine, Wis.

For more information—
Circle 7, inside back cover



Friction Clutch for Power Transmissions

This clutch is said to be especially suited for applications where increased speeds prohibit use of jaw clutches and where smooth, gradual pickup is a requisite. An "over the center" toggle mechanism is used. This assures positive positioning and minimizes the possibility of accidental engagements or disengagements. It also allows drag-free idling.

Heat dissipation is reported to be high because the friction surfaces are substantial castings directly cooled by air. A split friction plate permits inspection without removing the clutch from the shaft.

The new clutch, with capacities up to 170 hp, at typical industrial speeds, is available with mounting sleeve, with mounting ring and with a friction clutch coupling for connecting in-line shafts. Link-Belt Co., Dept. PR, 307 N. Michigan Ave., Chicago 1, Ill.

For more information—
Circle 8, inside back cover

Ball and Disk Integrator

Various types of control rods, ⅜ in. dia, can be supplied with vernier end, rack end, or plain, for these integrators. In addition, special lengths and configurations can be manufactured.

This precision comparatively low torque speed changer is used for gen-

CONTINUED ON PAGE 222

MECHANICAL SEAMLESS

ELECTRIC-WELDED

AIRCRAFT SEAMLESS

AIRCRAFT MECHANICAL

FABRICATING and FORGING

OSTUCO Tubing Specialists have vast application experience in *your* industry. This storehouse of design and production know-how can improve your product and trim costs too.

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—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
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CANADA, RAILWAY & POWER ENGR. CORP., LTD.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York

erating variable speeds in a smooth and stepless fashion. Reflectone Corp., Stamford, Conn.

For more information—
Circle 9, inside back cover

Lock Nut Also Seals

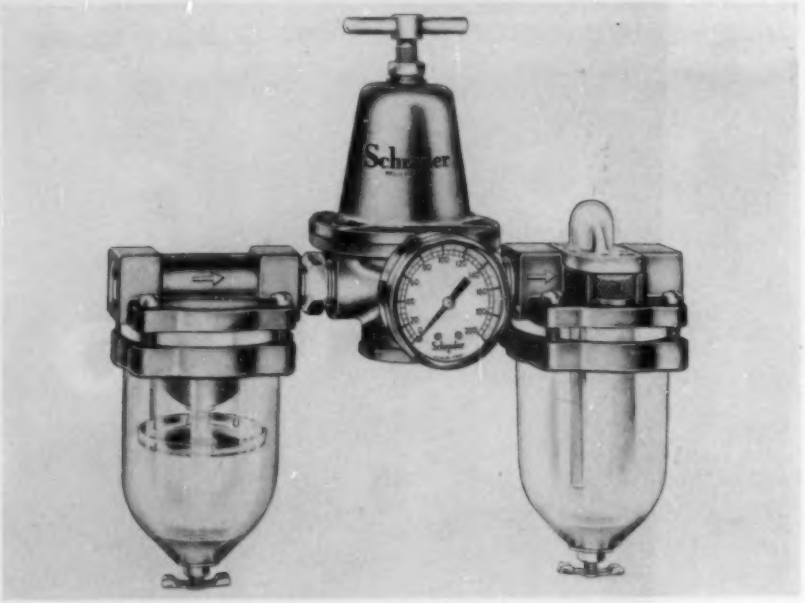
The addition of a sealing compound to these lock nuts provides a seal around threads and the nut seat when tightened. The resilient spring steel construction reduces damage to studs, screws and fastened parts, and cushions the shock of power drivers. Spring locking force is exerted inward on the threads and downward on the base to prevent loosening under vibration. Large washer base spans stud or screw holes, and cannot chafe edges to cause corrosion. Available in 8-32, 10-24, 12-24 and ¼-20 sizes. Palnut Co., 61 Cordier St., Irvington 11, N. J.

For more information—
Circle 10, inside back cover

Panel Fastener

A positive-locking structural fastener said to be adaptable to panel fastening of demountable buildings, shipping containers, aircraft cowlings, guided missile assemblies, sheet metal guards and partitions, and to all butt-joint fastening, can be mounted by recessing in panels or can be surface mounted on sheets, panels or assemblies. It is vibrationproof and impact-proof; trigger action insures full-open and full-closed positions. Double-acting take-up reportedly insures heavy closing pressure and provides pressure-tight seal when gaskets are used. It will withstand 7000-lb tension and can be readily modified for light-load applications. Simmons Fastener Corp., 1700 N. Broadway, Albany 1, N. Y.

For more information—
Circle 12, inside back cover



Lubrication for Air-Operated Equipment

For service with air-operated tools, cylinders and valves. This unit is a combination filter, regulator and lubricator. It is fully automatic and serviced without removing from the pipe line. The filter has a large area sintered bronze filter, baffle plate and drain cock for blowing out water and accumulated foreign matter. The regulator adjusts air flow from 250 psi inlet pressures down to 5 to 125 psi by simply turning regulator handle. Pressure gage can be mounted front or rear of regulator.

The lubricator has a vibration-proof adjustment thumb wheel which regulates oil flow from a steady flow down to intermittent drops as needed. The transparent bowl holds a full half pint, and shows oil level at all times. The new lubricator is available in three sizes, ¼, ⅜ and ½ in. NPT. A "sight feed" arrangement makes checking on this unit easy. A. Schrader's Son Div., Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 38, N. Y.

For more information—
Circle 11, inside back cover

Threaded Bolt Spacer

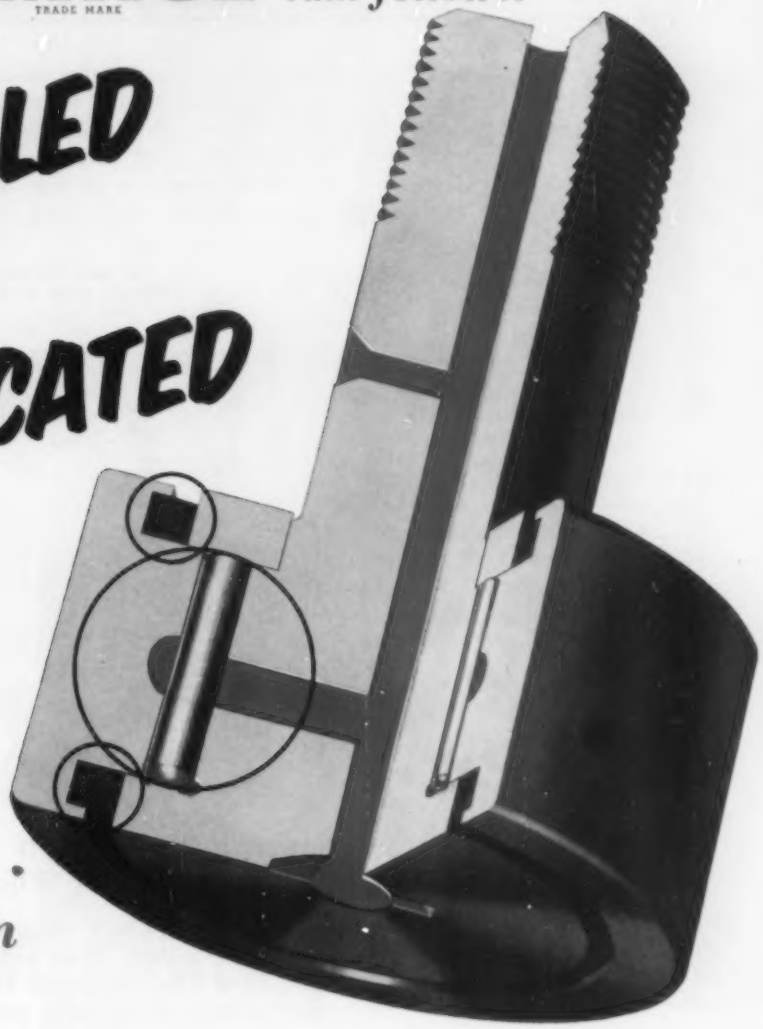
A self-locking threaded type of bolt spacer for structural fastening is designed for applications where lightweight and vibration resistance are important requirements. The spacer is a two-piece unit consisting of a plug and a tapped sleeve containing a self-locking nylon insert. The tapped sleeve receives the attaching bolt and eliminates the use of a nut. The lock is effected by a durable nylon insert located in the tapped sleeve section of the spacer.

These new spacers are available in No. 10 screw size for panel thicknesses

CONTINUED ON PAGE 224

the NEW McGILL® **CAMROL** TRADE MARK *cam follower*

NOW SEALED and PRELUBRICATED



to eliminate contamination . . . save re-lubrication

McGILL®

SCF series

CAMROL TRADE MARK

bearings

Write for your copy today

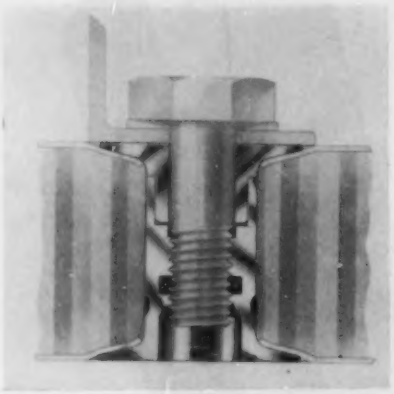
In one simple assembly, the Sealed CAMROL cam follower bearing gives you three big advantages: 1. capacity to withstand the shock and load of cam action, 2. sealing against contamination that would impair the life of an unprotected bearing, 3. prelubrication that saves frequent relubrication so often undesirable in cam action application. Specially traeated seals are built in at stud and flange ends, and a black oxide finish offers outside corrosion resistance. A channeled reservoir in the outer raceway bore helps store reserve lubrication sufficient in many cases for lifetime service. The new SCF series bearings do not add to the size or weight of standard CAMROL cam followers and are dimensionally interchangeable with them. Ask your McGill representative to show you this newest McGill contribution to the superior performance of your cam actioned machinery, or write to our engineering department for recommendations. Send for Bulletin SCF-55 for more detailed information.

50th McGILL Anniversary

Insure performance with McGILL®...

MULTIROL®—GUIDEROL®—**CAMROL** *full type roller bearings*

McGILL MANUFACTURING COMPANY, 201 N. Lafayette Street, Valparaiso, Indiana



from ½ to 1¼ in.; No. 8 and ¼-28 screw sizes will soon be available. Material is 24 ST-4 aluminum alloy, anodized. Delron Company, Inc., 5224 Southern Ave., South Gate, Calif.

For more information—
Circle 13, inside back cover

Plastic Cable Clamp

A one-piece nylon clamp for holding wires, cable and tubes has a curved-base design and snap-in feature that provides a tight, rattle-free application. A variety of wire and tube sizes plus a range of panel thicknesses can be accommodated with this fastener. Shakeproof Div., Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

For more information—
Circle 14, inside back cover

Balls of Nickel Alloys

High-strength nickel-base alloy balls are now available from stock in 16 standard sizes, from ⅛ to 1½ in. dia. These balls have resistance to corrosion, hardness ranging from 180 to 238 Bhn and ultimate strength up to 140,000 psi at room temperature and 76,000 psi at 1300 F. They are rough-forged from wrought alloy stock and are ground and polished to a tolerance of ±0.001 in. on size and ±0.0001 in. on sphericity. They have a finish of 1 microinch roughness or less. Industrial Tectonics, Inc., Ann Arbor, Mich.

For more information—
Circle 15, inside back cover

Conveyor Wheels With Replaceable Rubber Wheels

Tires on these wheels are made of oil resistant rubber. Thirty-two fins across 1¾ x 4 in. roll permit tire to "give" without being cut or torn by the moving load. The rubber tire slips on and off by applying pressure on the metal hub—no tools necessary. No need to remove wheel from conveyor. Manufactured in standard sizes or modified to suit individual requirements. Cougar Engineering Co., 12017 Woodbine, Detroit 28, Mich.

For more information—
Circle 16, inside back cover

Non-Lubricated Pulley

A ¾ hp variable speed pulley that can be readily adapted to new or old equipment has been developed. Oil-impregnated bronze bearings are used, thus eliminating the necessity of lubrication for the life of the unit. The pulley delivers a speed ratio of 2¾:1, using an A-section belt. Maximum bore is ⅞ in. with keyway. The shaft bore runs through the entire length of the pulley, giving the added

advantage of reverse mounting when necessary on special installations.

The unit measures 4$\frac{13}{16}$ in. overall length, 6 in. dia. Weight is 6½ lb. Lovejoy Flexible Coupling Co., 4873 W. Lake St., Chicago 44, Ill.

For more information—
Circle 17, inside back cover

Socket-Head Set Screws

Socket-head set screws that can be tightened up to 40 per cent tighter and which are said to have greater holding power than ordinary set screws are available in a complete range of sizes from No. 0 up to 1 in. dia. Standard Pressed Steel Co., Jenkintown, Pa.

For more information—
Circle 18, inside back cover

Air-Powered Vise

This vise has 6x6 in. jaws, with a 5 in. OD push rod and a 6 in. air stroke. It develops 1900 lb gripping force at 100 psi line pressure. The large push rod is asserted to assure positive guidance and rigidity.

With a maximum opening of 8 in., the vise is designed for use in light milling or forming, for all production drilling and tapping requirements and as an air clamp on cut-off saws. The jaw faces are removable, and can be drilled and tapped for attachment of fixtures and dies. Van Products Co., 3736 W. 12 St., Erie 2, Pa.

For more information—
Circle 19, inside back cover

Anchor Nut in 2-56 Size

A 2-56 thread size is now available in a self-locking anchor nuts. The locking principle of this fastener

CONTINUED ON PAGE 226

Like the submerged 7/8 of an iceberg, the important part of each SKF bearing is value you cannot see...

– the value of prompt product-design assistance from SKF 's field engineers in your area—the most experienced in the industry.

– the value of additional help from SKF home office specialists *in your industry*.

– the value of unbiased recommendations, possible because SKF makes *both* ball *and* roller bearings.

– the value of SKF laboratory research to solve unusual anti-friction problems.

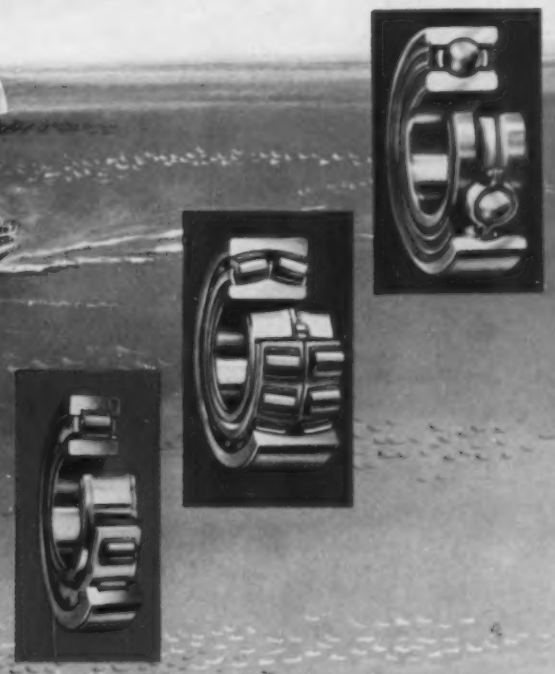
– the value of SKF quality control that assures the bearings in your product are the finest made.

Product-design men in all industries have discovered the tangible benefits of these "hidden values". They know that satisfactory service life and dependable product performance are often simply the result of *the right SKF bearing in the right place.*

7000

in Bearings as in Bergs,

BIG THINGS ARE FOUND BENEATH THE SURFACE



SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
manufacturers of SKF *and* HESS-BRIGHT® *bearings.*

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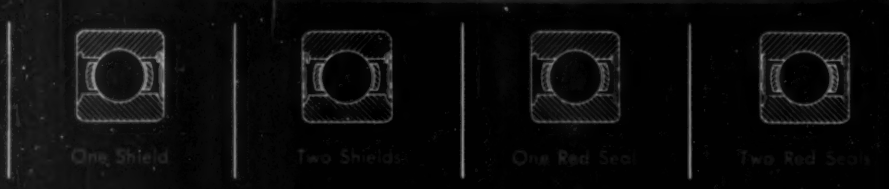
SKF makes them all

SKF's comprehensive line of Filling Slot and Deep Groove Ball Bearings (*some* of which are shown here) is typical of the complete bearing service which **SKF** provides. That is why you get unbiased advice based on exceptionally *broad* experience when **SKF**'s product-assistance staff helps you put the right bearing in the right place in your product.

7600 A

Single Row, Filling Slot (Max Type) Ball Bearings

Single Row, Deep Groove Ball Bearings



SKF

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
manufacturers of **SKF** *and* HESS-BRIGHT® *bearings*

Form 419-S-55

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Report to Cylinder Users . . .

Here at Miller Fluid Power we have a pattern which we follow. A goal at which we are shooting. The pattern isn't too simple. And the goal isn't an easy one. But we've been making progress. Our position right up in the van of the industry proves that.

Our job is the production of cylinders. Basically, there's nothing anyone can do to alter a cylinder. It was old a hundred years ago. It probably won't change basically in another hundred years. But in the details of the cylinder, change is the major element.

Which is very much like industry itself. Basically, industry has not changed since free enterprise was conceived on this continent. But in every detail it changes from year to year.

It's the Thousandths That Count

There was no single big thing wrong with the cylinders being manufactured yesterday. Just a lot of little things. So Miller Fluid Power made the improvement of little things its business.

We experimented with new materials and made safer, more dependable steel heads and caps. We hard-chrome-plated 110,000 PSI yield point steel to improve radically the piston rods. We raised the efficiency of operation to new peaks. Striving for quality in the smallest detail we improve in a dozen parts which are hidden from sight.

For instance, most cylinders leaked in operation. Miller made one that wouldn't leak. To prove it, we went away out on a limb and guaranteed leak-proof operation. And made the guarantee stand up.

We Learn by Listening to You

We saw our customers as thousands of men in thousands of shops wrestling with thousands of production problems. We made those problems ours and produced cylinders to whip those problems. Maybe we didn't revolutionize the cylinder business in the process. But we sure helped. We know that.

We learned to produce what we believed was the best cylinder on earth. We also learned that the best cylinder today wouldn't be good enough tomorrow. So, with the good one in production, we listened some more, experimented, and came up with a better one.

Miller Fluid Power is a young company in an old field. We are young, progressive, and willing to listen. We innovate without being prodded.

Discussion is a Two Way Street

On occasion we like to have others listen to us. Especially when what we have to say will help our customers. That is the idea behind our College of Cylinder Knowledge. We know a lot about cylinders. Though not as much today as we will tomorrow or the day after.

In our College of Cylinder Knowledge we try to show you what good cylinders can do for you. And what you should demand in any cylinder you buy. We meet other men who know what they want in a cylinder. We listen to their wants and try to explain what perfection in detail means.

We believe that when the users of cylinders sit down across the table from the producer who is trying to make the best, better cylinders result.

We'll be carrying that belief into the Production Engineering Show at Navy Pier in Chicago on September 6. Our College of Cydinder Knowledge booth will be open for that kind of discussion. We'll listen and learn.

The only way we can learn is from you. We can help you. But not until you've dropped that problem of yours in our lap. Your problem contains the stuff of which the better cylinder will be made. The cylinder that will have that quality plus which we like to think is the stamp of Miller Fluid Power.

Remember this when you see the sign over Booth 1819-23. We'll be there to listen to your suggestions, demands and questions. Also, because we are in the cylinder business, we'll be there to show you a cylinder you will want to buy.

Frank Flick

President

MILLER FLUID POWER COMPANY

2002-04 N. Hawthorne Avenue

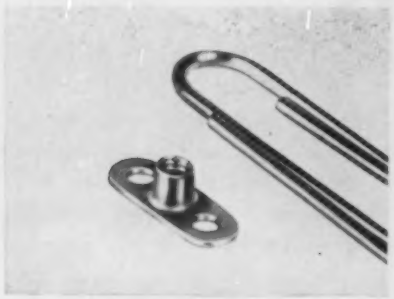
Melrose Park Illinois

Visit Miller

BOOTH #1819-1823

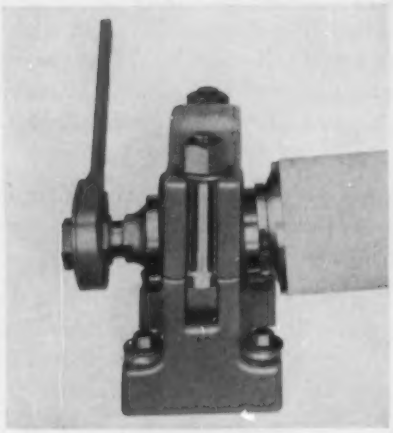
Production Engineering

NAVY PIER SHOW CHICAGO



causes the upper threads to be made elliptical and highly resilient, an auxiliary locking device. An all-metal nut, this product can be used in temperature ranges up to 550 F. Kaynar Co., 820 E. 16 St., Los Angeles, Calif.

For more information—
Circle 20, inside back cover



Split-Type Roll Bracket

These brackets were designed for the paper manufacturing and paper converting industries. The drawing shows the bracket used with 6¾ in. dia. expanders. A hinged eye bolt flips to the side when loosened, allowing the top of the bracket assembly to open upward on its hinge. This is said to make it easy to remove expanders for service.

The expander and bracket assembly also includes a built-in ratchet wrench for easy adjustment of expander bow position. A cut-out saddle provides a convenient spot for attaching slings when a winch is used to lift out rolls. Mt. Hope Machinery Co., Taunton, Mass.

For more information—
Circle 21, inside back cover

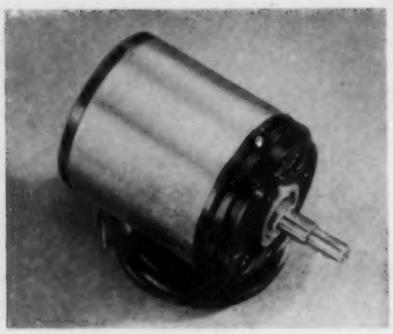
Levers From Standard Forgings

Now assembled from standard, stocked forgings without requiring special dies or tooling, these levers are suitable for start, stop and other controls on earth-moving machinery, trucks, buses, hydraulic equipment, hoists, cranes, pumps, materials handling equipment, oil field rigs and draw works and other, similar equipment.

Upper and lower half assembly forgings, hubs, sub levers and extensions are all available. With all parts interchangeable, any upper half assembly forging may be joined with any lower half assembly forging or any sub lever forging to produce the lever desired for a particular application. Batavia Metal Products Corp., Batavia, N. Y.

For more information—
Circle 22, inside back cover

ELECTRIC POWER, CONTROL



Single End Magnetic Clutch

A high speed, precision electromechanical component for all types of control, computer and servo systems can be mounted on a single hanger like any standard servo motor. Concentric input and output shafts on the mounting end of the unit permit all gearing to be located at this end. Sterling Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.

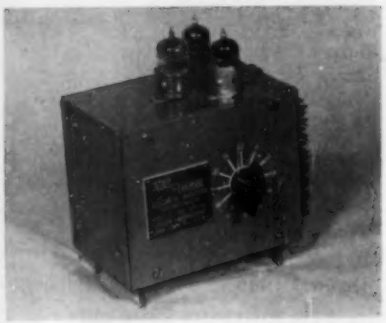
For more information—
Circle 23, inside back cover

Magnetic Amplifier Packaged Speed Control

This device is a full-wave, self-saturating magnetic amplifier, with standard speed control range of 10:1. The use of full-wave conversion allows the use of a motor size one frame size smaller than that required for half-wave units, since there is less heating on full-wave applications.

The Bulletin 6520 speed control is completely self-contained, including field supply, control circuit, short circuit and overload protection; operates on 110 v, 60 cps current. Clark Controller Co., Cleveland, Ohio.

For more information—
Circle 24, inside back cover



D-c Signal Voltage Controls Circuits

This servomechanism contains a rotary selector switch with shaft extension which automatically rotates in discreet steps in response to a d-c signal voltage. For 1 v input, the shaft rotates to "one o'clock". For 2 v input, the shaft rotates to "two o'clock", and so on. Connections to the switch can be made through the external terminals so that the user has available both a rotating shaft position as well as switch connections through which other circuits may be controlled. Among the possible applications are: process control, amplifier gain control, parts sorting, meter range switching,

CONTINUED ON PAGE 228

IN POWDER METALLURGY . . . IT'S AMPLEX

The Bearing That Wouldn't Wear Out

125 years service without adding a drop of oil*

How long will a bearing last? An OILITE customer making large vertical shaft attic fans wanted to know the answer. He subjected a fan equipped with an OILITE bronze flange bearing to an *accelerated life test equivalent to 125 years of service. Throughout the test it ran quietly and smoothly. *Not one drop of oil was added—it showed no apparent wear.*

OILITE bearings hold oil by capillary attraction. Oil film on the surface insures positive, constant lubrication. Particularly good in trouble areas where lubrication is difficult or impossible. The built-in oil cushion allows OILITE Heavy-Duty Bearings to absorb shocks and stresses.

Heavy-Duty, self-lubricating OILITE bearings are Chrysler engineered to meet individual requirements. Standard bearings are available from local dealer stocks. Also cores, bars, plates, discs and strips in sizes ranging from ½" to 15¼" I.D. and 1" to 18¼" O.D.

The engineering facilities of Amplex and Chrysler, unmatched in the powder metal industry, are ready to help you with your bearing problems. For on-the-spot service, consult your telephone yellow pages for the field engineer near you.

CHRYSLER AMPLEX PRODUCTS

OILITE Bearings
Permanent Metal Filters
Finished Machine Parts
Friction Units

Write for free 24-page OILITE Bronze Precision Bearings bulletin S-53.

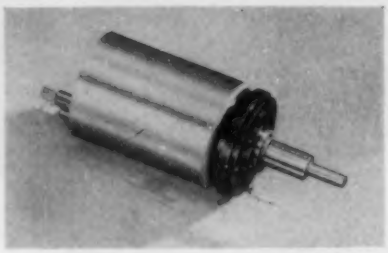
OILITE — *Only Chrysler makes OILITE*

CHRYSLER CORPORATION • AMPLEX DIVISION

Dept. F-9 — Detroit 31, Michigan

over or undervoltage control, telemetering, multiplexing and similar applications. Bergen Laboratories, 11 Godwin Ave., Fair Lawn, N. J.

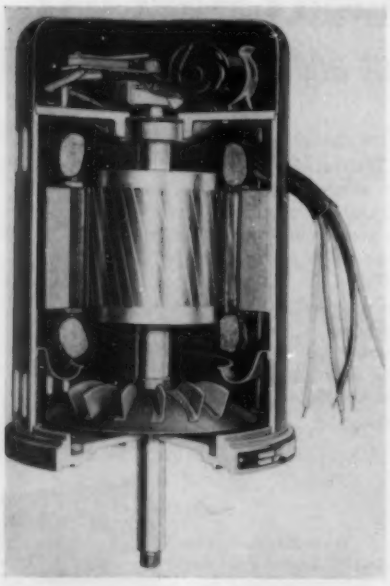
For more information—
Circle 25 inside back cover



Miniature Magnetic Clutch

Single-ended concentric input and output shafts are located at the mounting end of this clutch permitting all gearing to be located at this end. Designed for use with MK 14 Mod O servo motor. Overall dia 1.062 in. Weight is 4.3 oz. Power consumption is 3.3 w. Sterling Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.

For more information—
Circle 26, inside back cover



Totally Enclosed Fhp Motors

With the addition of vent slots to the main frame, this motor also has a controlled ventilating system. Airflow is aimed at the coils; ball bearings are practically out of the air stream, with the result that contamination of bearings by air-borne grit is minimized. Motor switch, starting capacitor and automatic overload protector all are conveniently end-mounted and protected by the enclosed canopy.

Mylar slot and phase insulation is used and is rag-paper-backed for puncture protection in the new motor, originally designed for jet motor service. The units are available in single and three-phase, ¼ through 2 hp in models designed for either horizontal or vertical applications. A. O. Smith Corp., 227-31 Helena St., Dayton 4, Ohio.

For more information—
Circle 27, inside back cover

Thumb-Sized Servo Motor

This motor was originally designed for use in a compass-controlled directional gyro-compass system. Rated at 26 v and weighing 1.2 oz, it is ⅝ x 1.2 in. long. Its no-load speed is 21,000 rpm, and it has exceptionally high acceleration, stall torque and efficiency for a motor of its size and type.

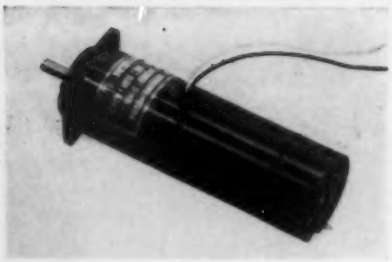
It is designed to withstand ambient temperatures in the range of −55 C to 90 C when operated as a control motor, and is built to provide satisfactory performance at altitudes up to 60,000 ft. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 28, inside back cover

Totally Enclosed Fan-Cooled Motor

The ventilating fan in this line of rerated 7½ to 100 hp motors provides the same efficiency of cooling when operated in either direction. The fan does not have to be changed. Rib-type cast iron frame construction is provided. These motors are recommended for use in dirty, dusty, fume and mist-laden atmospheres. Century Electric Co., 1806 Pine St., St. Louis, Mo.

For more information—
Circle 29, inside back cover



Servo-Actuator Motor Package

Designed for servo-actuator purposes where exceedingly high speed in starting and stopping of the operating shaft without slip is required, this package consists of a 1¼ in. dia permanent magnet, 115 v, d-c motor clutch-brake mechanism, clutch-brake actuating housing, a gear train. All components are incorporated into a homogeneous housing.

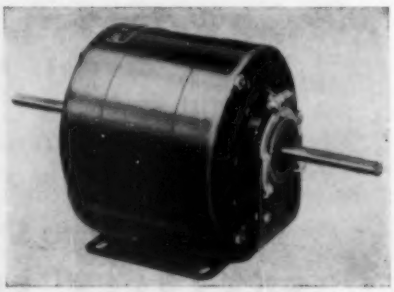
This package is 1¼ x 3⅜ in. long. This unit can be supplied in a variety of torques, output speeds, and is suitable for all standard d-c voltages. Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.

For more information—
Circle 30, inside back cover

Permanent Split Capacitor Motor

A new line of permanent split capacitor motors which are said to offer the low cost and ruggedness of shaded-pole types, plus the excellent torque characteristics of a distributed, wound capacitor motor. Pressed steel cases are used, with self-aligning bearings having the design characteristics of sleeve bearings.

These motors are designed especially for direct-drive blowers for refrigeration, heating and air-moving



CONTINUED ON PAGE 230

NO SHOCK MOUNT EVER HAD IT SO TOUGH

That's why *ALL-ANGL* Barry mounts are used in MARTIN's *MATADOR*

Under the cumulative shock of rocket-boosted zero-length take-off, jet-fighter flight maneuvering, and on-target dive that cracks the sound barrier, the nation's first operational pilotless bomber relies on ALL-ANGL Barrymount® isolators to protect critical electronic control gear.

Equally effective in every flight attitude, ALL-ANGL mounts permit bulkhead mounting that saves vital space in this deadly weapon. And their proved performance makes Barry mounts Martin's choice for the Matador

Let us show you how Barry's new ALL-ANGL isolators can lick *your* tough mounting problems. Data sheet M-9 gives mechanical and dynamic specifications. For specific recommendations, call your nearest Barry Sales Representative.

PHOTOGRAPH COURTESY THE MARTIN COMPANY

BARRY CONTROLS
INCORPORATED

730 PLEASANT ST., WATERTOWN, MASS.

equipment, vending machines and many other applications. Available in all ratings up to ¼ hp. Fosco Industries, Inc., Rochester, N. Y.

For more information—Circle 31, inside back cover

Shorter End-Mounted Motors

These flange-mounted motors replace this manufacturer's former unit in the 1 to 15 hp range. Flange dimensions are according to NEMA standards, for interchangeable mounting with all other makes of standard end-mounted motors. The new motor can be furnished in either open type frame or totally enclosed, fan-cooled type, for vertical or horizontal operation. Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

For more information—Circle 32, inside back cover

Low-Speed Synchronous Inductor Motors

Two synchronous inductor motors, self-starting and reversible without gears, are available in 20 and 54 frame sizes. The low speed motors accelerate to synchronous speed in ½ cycle or less, and the permanent magnet rotor stops within 7 deg with moderate external inertia. The 54 frame motor, with a torque rating of 75 oz-in., is designed for use on motor-operated valves and rheostats, industrial process timers and recording devices. Other applications include operation of cams and levers, replacement of solenoids, machine tool traverse feed drives, and defense applications. Torque rating of the 20-frame motor is 2 oz-in at 100 rpm. It is designed principally for application on higher torque time measuring and sequence timers.

Both motors are of three lead designs reversible by a single-pole double-throw switch. The motors start, stop, and reverse very rapidly and will withstand stalling without overheating. Designated type SMY, the 20 frame motor is available at 100 rpm in the 60 cps, 115-v rating and at correspondingly reduced speeds on 50 and 25 cps. The 54 frame is available at 75 rpm for 60, 50 and 25 cps at both 115 and 230 v. General Electric Co., Schenectady 5, N. Y.

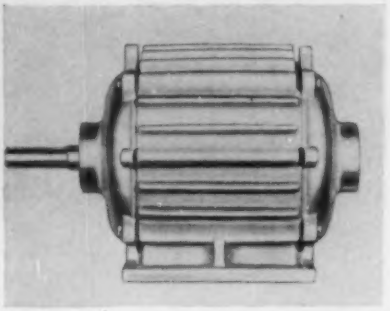
For more information—Circle 33, inside back cover

Mobile A-c Power Unit

A portable source of a-c power that delivers up to 10 kw at 110-220 v uses as a prime mover the engine of the vehicle in which it is carried. The unit supplies alternating current at commercial voltages and frequencies, or single or polyphase.

The two-pole alternator, which forms one half of the two-part unit, may be mounted under the vehicle hood and driven by a V-belt from a sheave on the crankshaft in front of the fan pulley, or by a power take-off. To keep down size and weight, excitation is provided by rectifying a part of the alternator output instead of using a rotating exciter. The other half of the system is the regulator, a static unit of the magnetic amplifier type with a selenium rectifier to provide alternator excitation. Operating characteristics are carefully matched with those of the alternator for optimum performance. Measuring 10 x 6 x 7 in., the regulator has encapsulated windings for protection against moisture and vibration. Units rated at 3, 5 and 10 kw are in production. Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co., 200 Bloomfield Ave., Bloomfield, N. J.

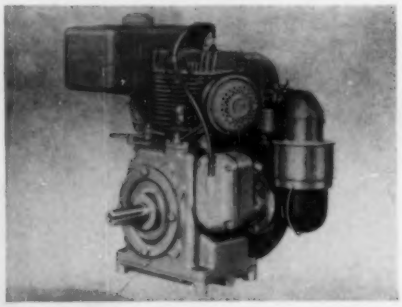
For more information—Circle 34, inside back cover



Fan Motors ¾ to 20 Hp

Double width, prelubricated sealed ball bearings with a non-hardening grease are used in this motor. Integrally cast fins provide greater heat dissipating surface and allow a smaller transverse section. Windings are polyvinyl-acetal insulated. A selection of connection boxes fit any air-over-motor application. Lima Electric Motor Co., 131 Findlay Road, Lima, Ohio.

For more information—Circle 35, inside back cover



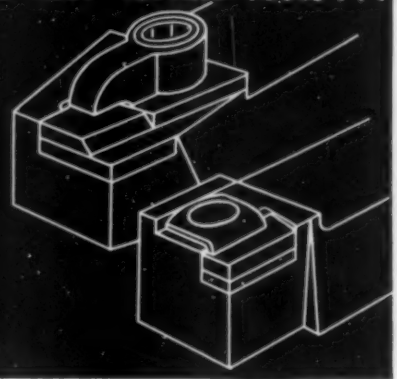
Four-Cycle, Heavy Duty Engine

The Model ACN has a piston displacement of 14.88 cu. in. and is designed to operate within a speed range of 1600 to 3600 rpm, delivering from 2.3 to 5.6 hp, with a torque curve of 92 to 104 in-lb. Tapered roller main bearings are used at both ends of the crankshaft and a gear-driven high tension magneto is mounted on

CONTINUED ON PAGE 232

LIKE ENGINEERED COST-CUTTING TOOLS . . . . . .

which permit speeds and feeds that would burn up yesterday's best, yet seem to run on and on with little sign of wear . .



CMP *cold rolled strip steel...*

CAN HELP YOU SAVE TIME AND CUT TOOL COSTS

Frequently, CMP can do as much and more to help you save time and cut tool costs as modern tools themselves.

By processing cold rolled strip steel to restricted specifications, it often is possible to develop working qualities that will permit forming operations to be speeded up as much as 25% without increased tool wear.

Again, qualities may be imparted to the steel which will permit simplification of tooling, and even elimination of operations.

And, always, because of the customary dimensional precision of CMP Cold Rolled Strip Steel, there is more footage per coil . . . fewer coil replacements are required on automatic-feed operations . . . there is less tool wear . . . fewer stops for tool changes and assembly is speeded.

You are invited to use CMP's experience along this line with a view to developing restricted specifications to cut your end-product cost.

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HIGH CARBON
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the outside of the engine and equipped with an impulse coupling for easy starting at low cranking speeds. Positive lubrication is provided by a pump-circulated splash system and the piston is equipped with four rings.

This engine can be supplied with various gear reductions, clutch assembly, with electric starter and generator, or electric starter alone. It can be equipped to operate on gasoline, kerosene, butane, propane or natural gas with minimum carburetion changeover. Wisconsin Motor Corp., Milwaukee, Wis.

For more information—
Circle 36, inside back cover

Non-Ventilated "Wafer" Brake Motor

Raising and positioning of a heavy cutting blade or the positioning of work on a lathe are typical of the jobs done by this brake motor. Other applications are found wherever short span power (5-min-on, 5-min-off) is needed to do the work of manual cranking and hoisting.

The dimensions of this new unit are $8\frac{5}{8}$ x $7\frac{5}{8}$ in. over-all length. Starting torques are up to 500 per cent of running torque.

These new motors are polyphase, totally enclosed and can be flange-mounted in any position. Motors are available in a variety of ratings of $\frac{1}{3}$ through $1\frac{1}{2}$ hp brakes from $\frac{1}{2}$ ft-lb through 25 ft-lb 1 through 10 min intermittent duty. Reuland Electric Co., Alhambra, Calif.

For more information—
Circle 37, inside back cover

Subminiature Motor Generator

Type MG3013 measures 1 x 2.625 in. length and weighs 6.2 oz. Output is 1.25 v per 100 rpm when operated into a load of 100,000 ohm. Speed is continuously variable from 200 to 8700 rpm. The output remains completely linear over the entire speed range. Harmonic distortion is under 5 per cent.

The motor is a 115 v, 400 cps, two-phase drive with a stall torque of 0.15 oz-in. The unit has a stainless steel housing with stainless steel ball bearings. John Oster Mfg. Co., 1 Main St., Racine, Wis.

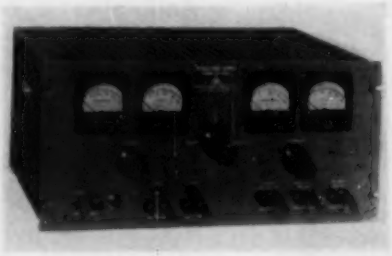
For more information—
Circle 38, inside back cover

Regulated D-c Power Supply

A line of 1.5 amp regulated d-c power supplies intended primarily for component use in original equipment have low temperature coefficient, wirewound reference networks and multipliers. Transformers and chokes are hermetically sealed. An anti-tamper voltage control is provided.

These power supplies are available in three ranges: wide (0-400 v, dc), intermediate (125 v band), and narrow (50 v band, centered at 25 v intervals from 25 to 375 v, dc). Dimensions are $12\frac{1}{4}$ x 19 x $16\frac{1}{2}$ in. deep behind front panel. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 60, N. Y.

For more information—
Circle 39, inside back cover

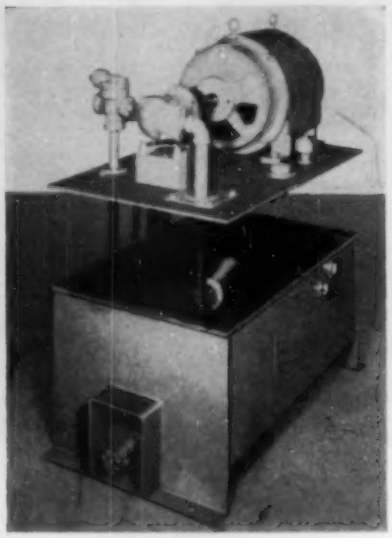


Dual Power Supply

A dual power supply that offers a switching arrangement that combines the d-c outputs in series or in parallel, doubling the voltage or current, occupies less bench space than two units usually needed to do the job. Cabinet is only $8\frac{3}{4}$ x 19 x 17 in. deep.

Eight outputs are provided: two for 30 to 500 v, dc, at 200 ma; two for 6.3 v, ac, 10 amp; one for d-c series connection; one for d-c parallel connection; one each for a-c series and parallel. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.

For more information—
Circle 40, inside back cover



Hydraulic Power Units

A line of standard hydraulic power units in five sizes, from $\frac{3}{4}$ to 20 hp, have stock hydraulic reservoir capacities of 20 to 100 gal. In conformance with JIC specifications, electric motors, pumps and necessary valves are mounted on the units; tanks are equipped with the basic required accessories (fittings, pipes, filler cap). Rosaen Co., 24601 Harper Ave., St. Clair Shores, Mich.

For more information—
Circle 41, inside back cover

Klystron Power Supply

This power supply provides beam voltages from 250 to 600 v at 65 ma, reflector voltages from 0 to −900 v at 50 microamp, square wave modulation between 400 and 2000 cps and sawtooth modulation at line frequency. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

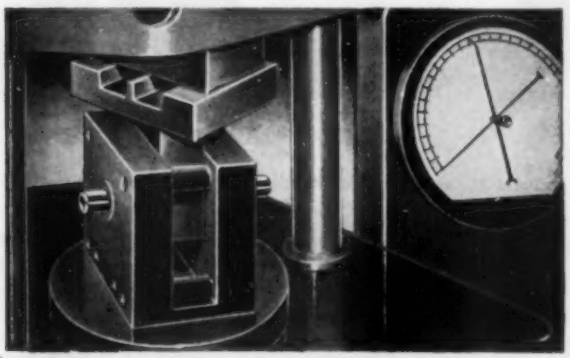
For more information—
Circle 42, inside back cover

Control Transformers

According to the manufacturer, all-welded construction and a new clamping structure have resulted in a transformer with greater mechanical strength and better electrical characteristics, with a reduction in stray

CONTINUED ON PAGE 234

Normal leverage puts the load on the pins at these points. Pins must have a high resistance to shearing — and every pin must stand up to plenty of abuse. Many manufacturers' tests have proved Rollpin's uniformly high shear strength.



We urge you to test spring pins before you buy — for uniformity of diameter and length, hardness, insertion and removal forces, and recovery of diameter, as well as shear strength.

consistent strength... as important in the pin as in the socket

The Moore Drop Forging Company, who manufactures the famous Craftsman wrenches for Sears Roebuck and Co., used stainless steel rivets to fasten the universal joint on their Flex sockets. Thorough testing, under all possible load conditions and drive angles, convinced them that Rollpin was stronger than the stainless steel rivet previously used. This led to a redesign of the joint with Rollpins replacing the rivets. Also, the spring tension inherent in the Rollpin locking principle was used to provide the "drag" that holds the socket head in angular position. The result . . . an improved product at lower cost.

Dependability like this is based on the rigid ESNA® quality controls that insure consistent strength and mean reliable performance by every Rollpin.

Moore Drop Forging Company was able to save assembly time, too. Rollpin is simply driven into holes drilled to normal production tolerances. It compresses as driven, locking itself in place by exerting pressure on the hole walls. In this case, the extra operation of spinning on a rivet head was eliminated.

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R29-92 **Elastic Stop Nut Corporation of America**
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Rollpin samples
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

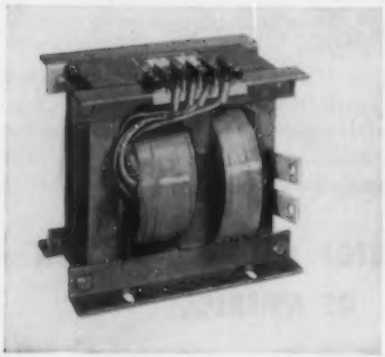
flux and its resultant power losses. Within each frame size, which is related to volt-ampere capacity, a wide variety of voltage combinations is available, with no change in over-all and mounting dimensions. These units are available in dual frequency (50/60 cps) and series-multiple ratings. The initial 11 transformer frame sizes announced by this manufacturer as available include the most popular ratings, 25 va through 2.0 kva for conduit wiring and 25 va through 250 va for open wiring. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 43, inside back cover

Voltage Ratio Transformers

These miniature units are said to be useful where voltage division or multiplication is required to accuracies up to 0.01 per cent. They are available in plastic encapsulated form or in hermetically sealed cases. Units having up to ten ratio taps are available. Accuracies are maintained by this transformer with moderate output loading. Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

For more information—
Circle 44, inside back cover



High-Impedance Transformers

Starting voltage is reduced automatically through the use of this current limiting or high-impedance transformer, which has flux shunts between primary and secondary windings. These shunts carry very little flux at no load; as the load increases, more flux is forced into the shunts until at short circuit all the flux flows through the shunts.

Some products which can be protected by the use of this device are electronic filament tubes, lamps, arc welders, high-impedance tube circuits and rectifiers. Capacities available range from 10 va to 25 kva. Nothelfer Winding Laboratories, Trenton, N. J.

For more information—
Circle 45, inside back cover

Power Transformers

A line of transformers is available, in both potted and regular styles. Stud single end bell, dual bell and dual bell vertical mounting arrangements are made. All primaries are 117 v, 50/60 cps. Moran Electronic Components, Inc., 10502 Wheatley St., Kensington, Md.

For more information—
Circle 46, inside back cover

Time Delay Relay

An electrical interlock in a circuit which allows pushbutton control can now be obtained by use of an instant action auxiliary switch in a time delay relay. Time delay is pneumatically-controlled and provides a readily adjusted and accurate timing interval from 0.1 sec to 10 or more minutes. Measuring $2\frac{1}{2}$ x $3\frac{3}{8}$ x $4\frac{1}{2}$ in. high, the new relay has a normally closed, double-throw microswitch attached to the front. Contacts of this switch are kept in open position by a lever connecting the auxiliary switch and the core. When the coil is energized, the core jumps up and these contacts close instantly allowing interlock. Simultaneously the time delay period starts and continues to the preadjusted time delay at which the main switch trips transferring contacts. In de-energization, auxiliary switch contacts change to open position and the main contacts transfer.

The relay is available for all a- and d-c voltages, in single-pole, double-throw, double-break and double-pole, double-throw, single-break models. The unit is rated 15 amp at 115 v, 60 cps, ac. Elastic Stop Nut Corp. of America, Elizabeth, N. J.

For more information—
Circle 47, inside back cover

Plug-In Relays

A general purpose power relay available in either ac or dc, two-pole, three-pole or five-pole models and smaller type available in ac or dc for operation up to 230 v are now available. Phillips Control Corp., Joliet, Ill.

For more information—
Circle 48, inside back cover

High-Speed Clutch Controls

A series of clutch controls for presses equipped with pneumatic clutch-and-brake units is offered in three enclosure sizes. All three are equipped to provide non-repeat protection and the functions of inching, single stroke and continuous operation; selection is controlled by the positioning of an exterior oil-tight selector switch. The small, basic con-

CONTINUED ON PAGE 236

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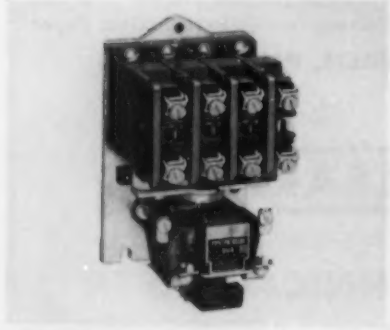
trol is designed to meet the average requirements of a high-speed press. The medium size control may be equipped for timed inching or with a Size 1 magnetic motor starter. The large size, which is built to conform to JIC and NMTBA standards, incorporates controls for press clutch and brake, size 1 starter for press drive motor, and externally operated, cover-interlocked disconnect switch. Optional functions of hand-foot, semi-continuous, and timed inching are all available on the large size panel.

Dual voltage (220-440v) primary transformers are provided. The air solenoid operates on 110 v, ac, from the transformer. The miniature, fast-operating relays are controlled from a rectified 90-v, d-c circuit. A double relay is used to control the air valve solenoid, reducing possibility of malfunctioning. Blocking rectifiers are used across the a-c air valve solenoid coil to reduce arcing at relay contacts and provide more consistent drop-out time of the solenoid. Fawick Corp., 9919 Clinton Road, Cleveland 11, Ohio.

For more information—
Circle 49, inside back cover



Heavy Duty Relays

A line of 10 amp control relays has been designed to occupy minimum panel space. The line includes relays with from two to twelve poles. The type PM relays have a sectional pole design. Each pole is mounted in its own individual melamine block. Poles are individually removable and replaceable without disturbing other poles or other wiring. Relays with up to eight poles are available without the complicated wiring and vertical space requirements of doubledecking.

Construction of the pole blocks is such that each pair of contacts is contained in its own arcing chamber, with melamine walls between poles. Two basic sizes of the Type PM relay cover all ordinary relay needs from two to eight poles, and two magnet coils for a given voltage will cover almost any combination of normally-closed contacts up to eight poles. Clark Controller Co., Cleveland, Ohio.

For more information—
Circle 50, inside back cover

Proportional, Delayed Reset Time Delay Relays

A line of time delay relays which provide a proportional delayed reset after current interruption can be supplied hermetically sealed in an extruded aluminum housing or in a standard dust cover. Their primary function is delaying application of plate voltage in gas and vacuum power tubes until filaments or heaters have reached the proper temperature.

Time delays from 5 sec to 1 hr and reset times from 30 sec to 7½ min. can be provided. Standard or governed d-c, or 60 or 400 cps a-c motors can be provided on these units. A. W. Haydon Co., Waterbury, Conn.

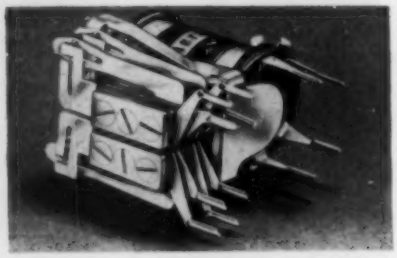
For more information—
Circle 51, inside back cover

Heavy-Duty, Low-Force Switch

A limit switch which can be operated with 2½ oz of force is designed for use on counting devices or similar applications which require heavy duty switches with light operating force. The actuating lever is a 5 in. aluminum rod, ⅛ in. dia, which can be bent or cut off. Operation can be clockwise or counter-clockwise. A full 60 deg overtravel permits use in applications where operating motions cannot be accurately controlled.

The new switch is available as a single-pole, double-throw and with a two-circuit break. Both of these are listed for 10 amp at 120, 240 and 480 v. Micro Switch, Freeport, Ill.

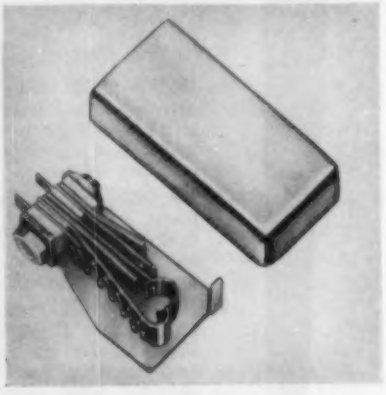
For more information—
Circle 51A, inside back cover



Printed Circuit Relay

A miniature relay for direct plug-in use in printed circuits permits direct insertion of the relay terminals into the printed circuit board, ready for immediate soldering. The plug-in terminals, instead of being brazed or welded together in sections, have been made integral parts of the coil terminals and contact springs to prevent internal loss in conductivity or continuity. The two contact arms of the relay permit two spring pile-ups of up to nine springs each. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

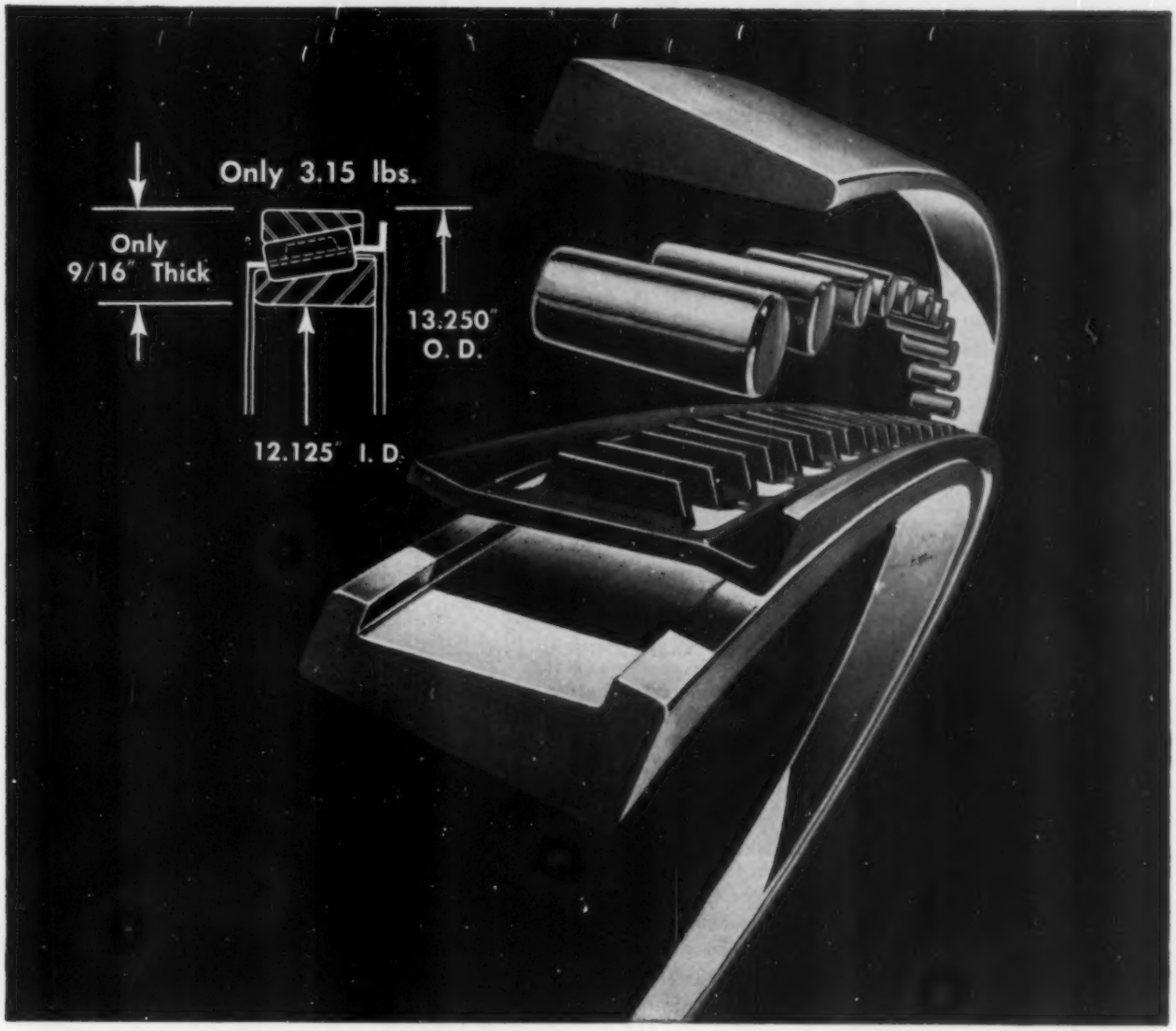
For more information—
Circle 52, inside back cover



Miniature Motor Overload Switch

A fhp motor thermal overload switch is designed for positive protection against overload current as well as frame overheating. When mounted on the motor frame, it picks up heat by conduction. Metal case provides complete shielding against rf interference. Voltage drop is slight because heating element has low resistance. The heater is bi-metallic, and operates contacts by snap action. Thermal cut-

CONTINUED ON PAGE 238



Kaydon...
world's thinnest tapered roller bearings

Reali-Slim — that's the name we've given our line of extremely thin-section, lightweight bearings. The bearing shown above is a *Reali-Slim*. *Reali-Slim* bearings are really strong, too! The single row, tapered roller bearing we're talking about, here, has a 33,000-lb. radial capacity—with 38,200-lb. thrust capacity. Over 1-ft. in diameter, yet it weighs only 3.15 lbs! These figures tell how *Reali-Slim* bearings combine minimum section with high strength and long life.

If you're looking for a whole new concept in thin-section, lightweight bearing design — look at Kaydon's *Reali-Slim* line. In addition to hundreds of *Reali-Slim* standard sizes, there's a big variety of special races and separators to meet special applications. Kaydon engineers are prepared to give you valuable help with your application problems.

For more information write Kaydon of Muskegon. Ask for engineering Catalog No. 54-RS detailing:

★ ***Reali-Slim Ball Bearings*** — in Conrad, angular contact and 4-point contact types are available in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40.000".

★ ***Reali-Slim Roller Bearings*** — in radial and taper roller types are available in cross sections from 9/16" and in bore diameters from 5" to 40.000".

K-552

THE KAYDON ENGINEERING CORP.

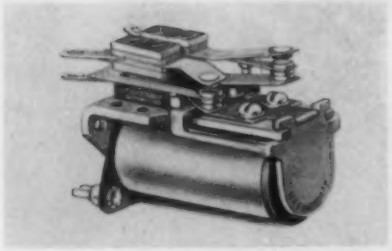
MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" to 120" outside diameter . . .
Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings.

out is factory set for 225 to 325 F, depending on user requirements, and operates independently of heater current. Units are self-resetting.

Maximum rating for this switch is 30 v, dc, 10 amp; 115 v, ac, 5 amp. Minimum opening time: 15 sec. Construction provides silver contacts and belyllium copper spring elements. Case dimensions: $\frac{33}{64}$ x $\frac{17}{32}$ x $\frac{11}{64}$ in. height. Nader Mfg. Co., 2661 Myrtle Ave., Monrovia, Calif.

For more information—
Circle 53, inside back cover



Miniature Power Relay

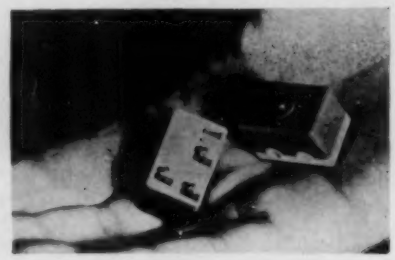
Reliable switching of heavy currents up to 10 amp and operating sensitivity are combined in a miniature power relay. Heavy current contact can be furnished in combination with bifurcated contacts for switching both heavy loads and low level signal loads with the same relay. Coil and contact terminals at mounting end of the relay facilitate concealed wiring of either individually mounted or strip-mounted relays.

Contact combinations up to four-pole, double-throw can be furnished, also hermetically sealed or dust-tight enclosure. This new relay is available for 60 cps ac, any voltage to 440 v; for dc, any voltage to 230 v. Magnecraft Electric Co., 3350 Y W. Grand Ave., Chicago 51, Ill.

For more information—
Circle 54, inside back cover

Sine Curved Snap Switch

A sensitive snap switch for applications requiring extremely small movement differential with high resistance to shock and vibration is said to maintain its operating characteristics throughout its life. Movement differential: 0.0005 in. min; shock: 200 G; temperature: −65 F to 350 F; life: 100,000 cycles, min. Rating: 10 amp at 115 v, ac, or 30 v, d-c resistive. Size: $1\frac{1}{8}$ x $\frac{7}{8}$ x $\frac{11}{16}$ in. Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

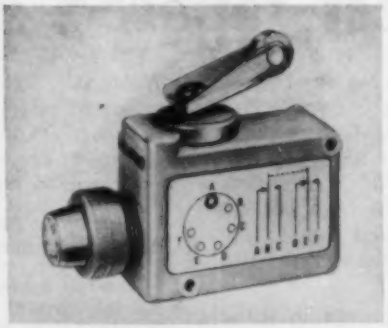


For more information—
Circle 55, inside back cover

Universal Counter-Timer

This counter-timer provides a direct digital read-out with decimal point indicated. Weighing 32 lb and measuring 15 x 7 x 13 in., ranges in frequency from 10 to 100,000 cps are provided. Time intervals of 40 microsec to 100,000 sec and a period range of from 1 to 10,000 cycles are offered. The time base is controlled by a temperature-compensated 100 kc crystal oscillator circuit having a stability of one part in one million. Power requirements are 117 v, ±10 per cent 50-60 cps, 175 w. Detectron Corp., N. Hollywood, Calif.

For more information—
Circle 56, inside back cover



Environment-Proof Switches

In addition to being sealed, these switches contain an inert gas, which is said to prevent their operations from being affected by atmospheric changes or severe environmental conditions. The switches are lightweight. They offer a variety of electrical rating and circuitry selections, and are available in either side or bottom-mounting designs. They conform to vibration and shock-resistance tests (MIL-S-6744) and meet immersion tests (MIL-E-5727A). Micro Switch, Freeport, Ill.

For more information—
Circle 57, inside back cover

Low Torque Selector Switch

This switch is available with several different brush and circuit combinations. A precision instrument bearing is used to minimize the driving torque of the rotor. Extremely low contact resistance has been achieved by the use of gold alloy brushes for input and output. The assembly is housed in a No. 10 synchro case. The overall size is less than 1 in. x $2\frac{3}{8}$ ing. long. The new switching unit is designed for ambient temperatures in excess of 350 F. Electro Tec Corp., S. Hackensack, N. J.

For more information—
Circle 58, inside back cover

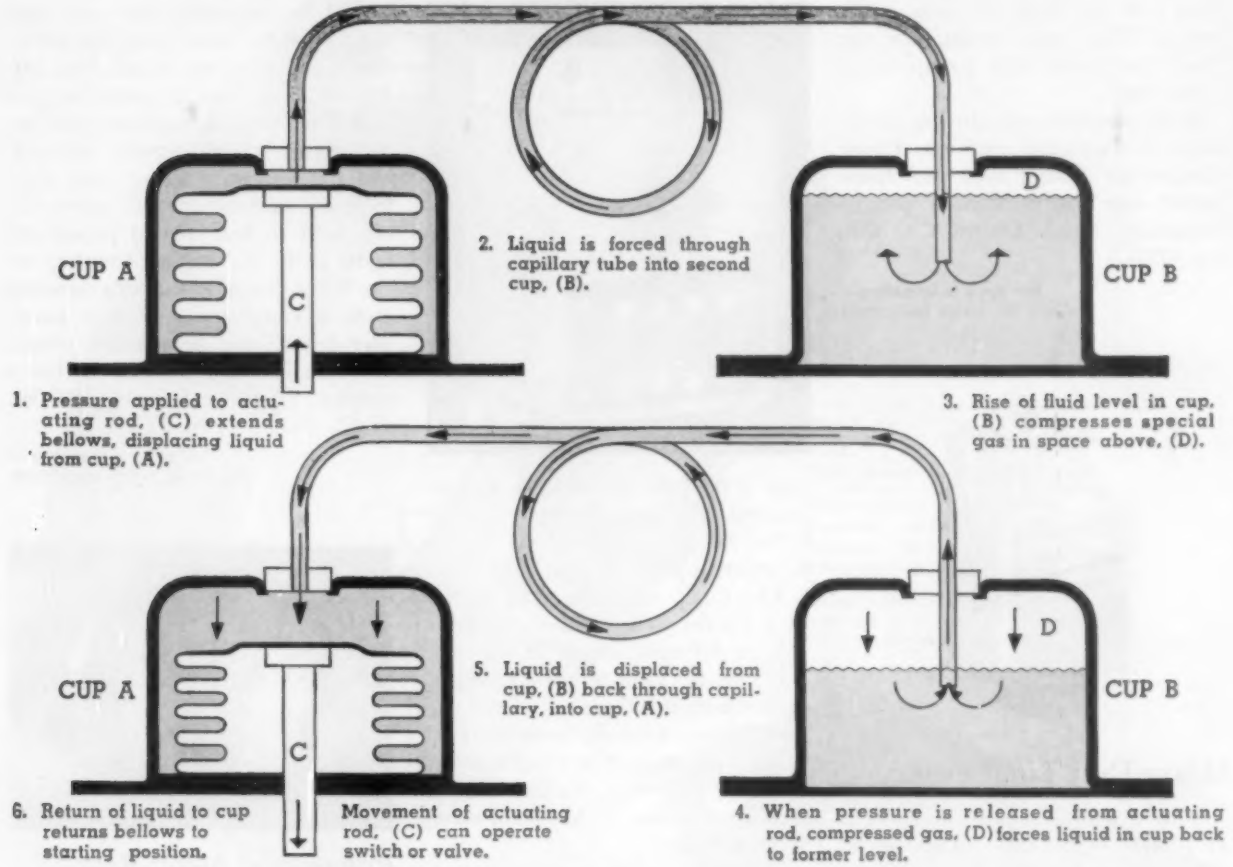
Rotary Switch

A 30-point, six-level rotary switch is built of molded ring layers, mounted directly on the switch frame. This assembly is available with either two rows of contacts per level or one row of contacts and one common ring contact.

Wiper assembly is designed to assure reliability of contacts, and prolong their life. Each wiper consists of two flat bifurcated springs, providing double contact surfaces at each level. These surfaces are in the form of

CONTINUED ON PAGE 240

How To Provide For Time-Delay Action With A Low Cost Bellows Device


CUP A
C
2. Liquid is forced through capillary tube into second cup, (B).
D
CUP B
1. Pressure applied to actuating rod, (C) extends bellows, displacing liquid from cup, (A).
3. Rise of fluid level in cup, (B) compresses special gas in space above, (D).
CUP A
C
5. Liquid is displaced from cup, (B) back through capillary, into cup, (A).
D
CUP B
6. Return of liquid to cup returns bellows to starting position.
Movement of actuating rod, (C) can operate switch or valve.
4. When pressure is released from actuating rod, compressed gas, (D) forces liquid in cup back to former level.

Simple Cup-and-Capillary unit operates hydraulically . . . provides delay times up to two minutes!

Time delay action can be accomplished with numerous devices. Electronic delay lines will provide delay times measured in microseconds. Electrical means such as relay circuits or motor powered timers, thermal means such as resistance wound bi-metallic strips and mechanical devices such as clock escapement mechanisms offer a wide selection of delay times.

Hydraulic devices, however, utilizing the movement of a flexible metallic bellows provide distinct advantages in many applications. Unlike either the electronic or electrical devices, bellows devices require no outside power. Unlike mechanical arrangements there are no springs, no moving parts, no mechanical linkage to break or get out of adjustment.

As indicated in the main illustration, the Clifford time delay unit consists of a standard bellows cup assembly connected by a capillary tube with another cup which forms an air tight chamber. Except for the inside of the bellows, the cup assembly (A) is completely filled with a liquid selected for the application. Cup (B) contains a measured amount of the liquid and the space above contains a special gas which is insoluble in the liquid. The capillary opening is so positioned that it terminates under the liquid and the gas is permanently trapped in the cup. An actuating rod is attached to the bellows in cup A.

Pressure applied to the rod extends the bellows, displacing the liquid from cup A, through the capillary to cup B. The rise in level in cup B compresses the gas temporarily and when pressure on the actuating rod is released, the compressed gas drives the liquid out of cup B back through the capillary and into cup A. With the return of the liquid, the bellows contracts and the resulting thrust of the rod can actuate switches or valves.

Delay interval is determined either by the time needed to displace the liquid from cup A to cup B or by the time necessary for the liquid to flow back into cup A and return the bellows to its original position. A filling liquid is selected whose viscosity remains essentially constant over the ambient temperature range to which the unit will be subjected. The hermetically sealed construction of the Clifford unit completely protects it from contaminants which tend to affect the time constant in units not so protected.

Standard units available. The Clifford Manufacturing Company can furnish standard units in production quantities having delay times of any selected period from one-quarter second to two minutes. Correct delay interval for the application can be obtained by selecting a suitable length and bore of capillary.

For appropriate units for your application, please send complete details covering: time constant required, force, ambient temperatures encountered and whether delay time is to be on forward or reverse stroke. **Clifford Manufacturing Company, 152 Grove St., Waltham 54, Mass.** *Division of Standard Thomson Corporation.* 7-5-67

Unit consists of two cup assemblies with appropriate length of capillary. It offers compact, rugged, hermetically sealed, low-cost design convenient for mounting. Time delay can be arranged for any interval from one-quarter second to two minutes and delay action can be on either the forward or return stroke.

HYDRON
METAL BELLOWS
CLIFFORD
MANUFACTURING CO.
WALTHAM, MASS.
DIVISION OF STANDARD-THOMSON CORP.
HEAT EXCHANGERS

"feet" at the end of each wiper spring. They make contact at the "heel" and break with a snap action at the "toe".

Bank assembly and driving mechanism is completely enclosed. Plastic window for contact bank and transparent case for mechanism permits inspection. North Electric Co., Galion, Ohio

For more information—
Circle 59, inside back cover

Heavy-Duty Limit Switch

This switch is conservatively rated at 10 amp continuous capacity up to 600 v, ac, 550 v, dc. It is available with ½ or ¾ in. conduit connections. Protection against excessive over-travel is achieved without shearpins. Complete separation of electrical and mechanical mechanisms is provided, along with nylon-to-steel wearing surfaces.

Continuous 30-deg overtravel can be accommodated without increasing maintenance problems or shortening life. If overtravel exceeding 30 deg should occur, the switch can be restored to service with a screwdriver. No replacement of shear pins or other parts is necessary. Clark Controller Co., Cleveland, Ohio

For more information—
Circle 60, inside back cover

Cold Cathode Tube Electronic Timer

This electronic timer has a built-in voltage regulator that overcomes the effect of line voltage variations. The timed interval is said to vary less

than 2 per cent of full scale for any line-voltage change between 95 and 125 v. On minimum settings there is an inherent error of 5 millisec.

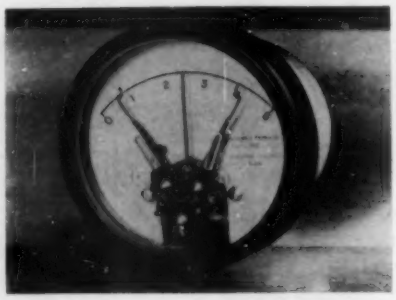
The timer, including case, is 5 x 4¼ x 3⅛ in. These timers are available in full-scale ranges of 0.2, 0.5, 1.5, 3, 6, 12, 24 or 60 sec. A variable control with 0-100 graduated dial permits setting intervals down to 0.03 sec for each range. The timer operates on 115 v (ac only). Farmer Electric Products Co., Inc. 21 Mossfield Road, Waban, Mass.

For more information—
Circle 61, inside back cover

Electric Impulse Counter

These counters are available with either manual pushbutton reset or electric reset. They are furnished either with a front plate for flush mounting or for surface mounting. The counters are completely housed and sealed. Power requirements are 0.8 to 3 w and the counters operate at up to 12 impulses per sec. The counters may be preset to any number to 99,999 by depressing the pins near the top of the front plate and simultaneously turning the wheel at the left. The pins can then be sealed to prevent tampering. As impulses come in, the upper (preset) register subtracts and the lower (counting) one adds. If desired, the counter will automatically reset to the original preselected figure at the end of each counting cycle. When this new counter's counting cycle is completed a built-in secondary contact can be actuated which, for instance, can operate a batch counter. Landis & Cyr, Inc., 45 W. 45 St., N. Y. 36, N. Y.

For more information—
Circle 62, inside back cover



Ruggedized Meter-Relay

The "trip" or control can be adjusted, from the front, to any point on the scale of this contact meter-relay. High limit, low limit or double (both high and low) contact arrangements are available. Sensitivity ranges are from 0.20 microamp to 0/50 amp, or 0/5 millivolt to 0/500 v. Higher ranges require external shunts or multipliers. Millivoltmeters, with temperature dials, have cold junction compensation. The contacts can be set for operation from full scale down to within 1 per cent of the zero point. Assembly Products, Inc., Chesterland, Ohio

For more information—
Circle 63, inside back cover

Plastic Front Instruments

This line of flush rectangular instruments have movements which are said to eliminate all inter-effect when mounted closely on the same panel, and to permit mounting on magnetic

CONTINUED ON PAGE 242

These typical properties show why Crucible 430 stainless was a good choice for the Murray worm drive clamp.

Tensile Strength — a. Room Temperature — 75,000 psi. b. At 1700F — 3500 psi

Yield Strength — 40,000 psi

Elongation — 30%

Hardness — 160 BHN

Endurance Limit — 40,000 psi

Creep Strength — Stress for 1% elongation in 10,000 hours at 1300F-1300 psi

Resistance to Scaling — Suitable for continuous service to 1600F.

the finest products wear a STAINLESS *label...*

When you label a product *stainless steel* it means lasting dependability . . . good looks . . . and resistance to wear or corrosion.

That's why the Murray Corporation, Towson, Maryland, chose Crucible stainless for the worm drive hose clamps shown above. These clamps need the high strength, wear and corrosion resistance that only *stainless steel* can provide.

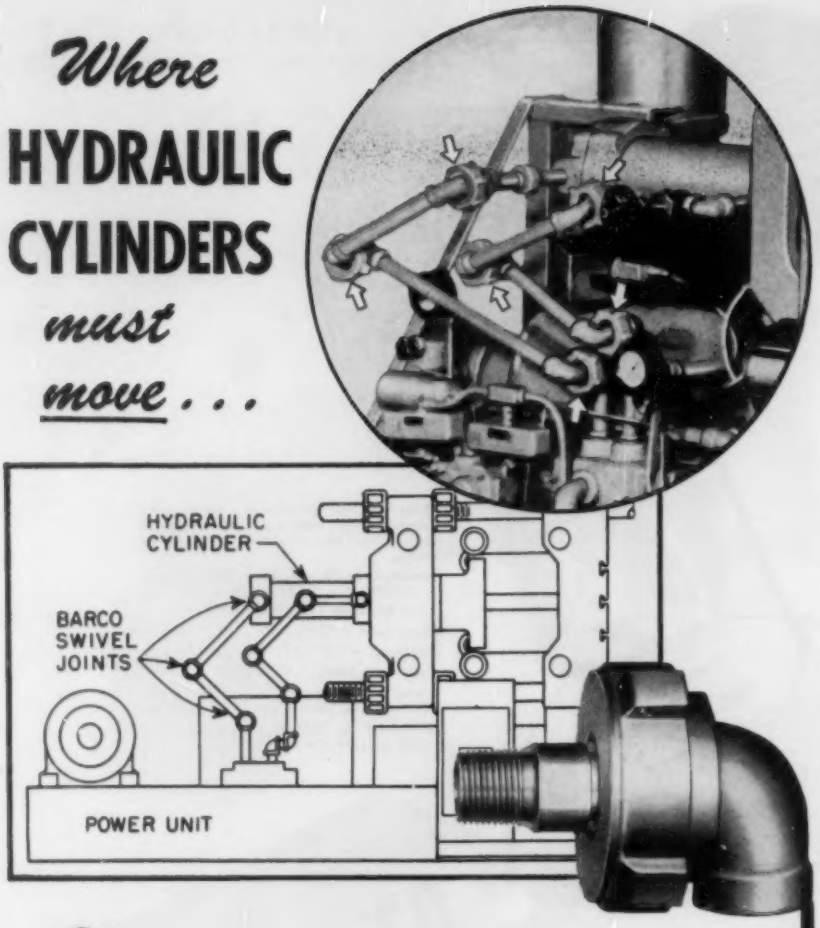
Stainless has other advantages, too. Its high creep and fatigue strength . . . heat resistance . . . and excellent workability may be just what you're looking for.

At Crucible stainless steels are *prescription-made* by steelmen with over a half century of experience in *special purpose* steelmaking. They'll welcome the opportunity to help you make the most profitable use of stainless for your products. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Where
HYDRAULIC CYLINDERS
must move . . .



Use
BARCO
Self-Aligning
SWIVEL JOINTS

THE Barco "Self-Aligning" Swivel Joint is one of the most useful, most versatile fittings ever developed for making flexible piping connections to moving or movable parts on injection molding presses, die casting machines, and other hydraulically operated equipment.

ENGINEERED INSTALLATIONS—Easy to position piping accurately. Put flexibility where you want it—without the nuisance of sagging, flopping, non-rigid lines. No restricted internal diameters.

BETTER CONTROL—No swelling or expansion in lines under pressure. Positive control action—no "mushiness."

PRESSURE SAFE—Barco Joints will not break or blow out suddenly. High temperature and fire resistance. Installations stay leakproof. No lubrication required.

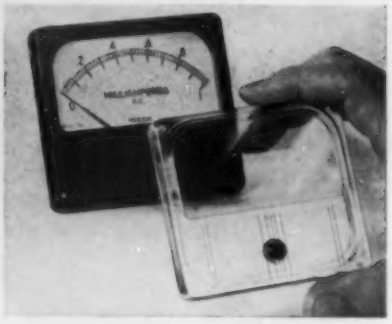
EASY TO INSTALL—Barco's *self-aligning* feature simplifies and speeds up installation, saves time in pipe fitting, prevents binding, and minimizes wear.

Barco builds a complete line of swivel joints for every purpose. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes ⅜" to 2"; angle or straight. For complete information and recommendations, see our nearest representative or write BARCO MANUFACTURING CO., 527K Hough St., Barrington, Illinois.

HELPFUL INFORMATION:
Bulletin 265B—"Barco Swivel Joints for Piping."
Bulletin 269—"High Pressure Hydraulic Swivel Joints."

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING, AND REVOLVING JOINTS



or non-magnetic panels without special adjustment. The instruments have a one-piece snap-on front with zero corrector, and the entire front surface, except for the window area, can be supplied in any color, including black. Case dimensions are 3.80 x 3.44 in. Available as d-c and rectifier type a-c instruments in popular ranges. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

For more information—
Circle 64, inside back cover

Potentiometer for Servo Or Bushing Mounting

As many as 14 sections may be ganged on a common shaft during manufacture, with as many as 17 taps added to any section. Each tap is spot-welded to a single turn of resistance wire. Measuring 1¾ x 1½ in. long with a ¼ in. dia shaft, operating range is −55 to 80 C. Power rating is 3.4 w at 25 C, 2.5 w at 40 C. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

For more information—
Circle 65, inside back cover

Nylon Wire Insulators

These snap-on insulators are available in two sizes for use with two sizes of splice caps, which splice nor-

BUILT-IN EFFICIENCY

Every Lamson fastener is designed to serve a particular application. For maximum efficiency, most economical assembly and most satisfactory appearance, choose the fastener that's "right for the job".

The fasteners shown here each have their place in your assembly line. Choosing the right fastener for the right job is one way to take advantage of their "built-in efficiency".

PHILLIPS HEAD

There are many reasons behind the design of the Lamson Phillips head. The "X" slot really clings to the driver bit for faster assembly. They are self-aligning and straight-driving, perfect for spiral or power drivers. They draw up tighter than a slotted head, without head loss or damage and they offer the best appearance on the finished job. These advantages are yours when you specify Lamson Phillips Head tapping screws and machine screws. Available in flat, round, oval, fillister, pan and truss head shapes.

SPIN LOCK

Lamson Spin Lock fasteners are designed to "bite" and hold. The ratchet-like structure of the teech prevents "backing off" when the fastener is set. This, obviously, makes for very high holding power. Five head styles: hex, pan, truss, flat and large flat. For tapping screws and machine screws that are vibration proof, easy driving, water and oil tight around the head and that tighten flush to surface, specify Lamson Spin Lock.

SEMS

These pre-assembled washer and screw units can really save you time. No fumbling for washers, no doubling of inventory and no special assembly techniques are just a few of the advantages. Sems are available with two washer types; toothed washers and helical spring washers, and a broad variety of screws. Head styles include flat, oval, truss, pan, round, fillister and hex.

CLUTCH HEAD

The straight-walled, shallow recess design of the clutch head offers real advantages in assembling procedures. The recess centers the driver. Because the slot is not tapered, any tendency for the driver to "climb out" is held to a minimum. This means greater safety and less driver pressure to draw up the fastener. The periphery of the head is unbroken, which means that you get a stronger screw, size for size, than any other type. In an emergency, Clutch heads can be serviced in the field with a common screw driver.

Complete information on these Lamson fasteners is yours for the asking

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

Lamson + Sessions

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS
Ideal for blind or hard-to-reach places.

PIPE PLUGS
Forged steel, heat-treated.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.

PLACE BOLTS
With "Built-in" spring action for positive locking.

LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS"
Including U bolts, eye bolts, hook bolts, etc.

MACHINE SCREWS
Clutch and Phillips recessed head screws.

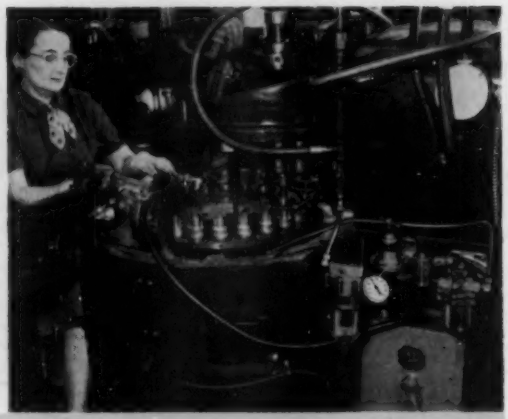
SEMS
Pre-assembled lockwashers on tapping and machine screws.

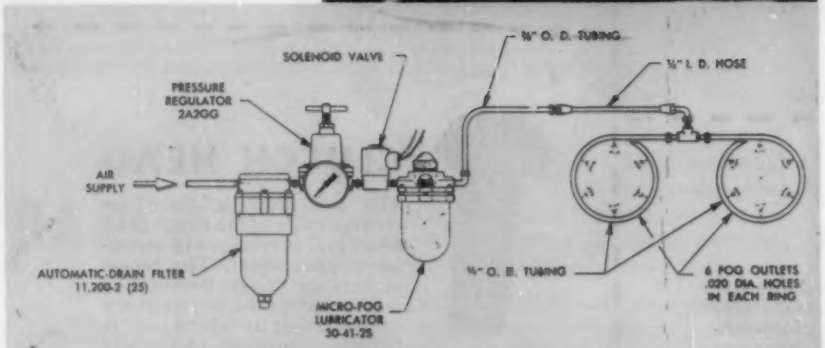
Norgren MICRO-FOG LUBRICATION
replaces coolant recirculating system

- **Saves $13,000 a year** by eliminating a parts degreasing operation
- **increases tool life 300%**
- **substantial saving in lubricant**
- **eliminated coolant recirculating system.**

ANOTHER PROFITABLE WAY TO USE MICRO-FOG LUBRICATION

Norgren Micro-Fog Lubrication replaced a flood system on this tapping machine having two simultaneously operated chaser heads which are chasing threads on zinc, die-cast ignition lock barrels. A mixture of cutting oil, oleum spirits and Suntac No. 151 is now applied at rate of 20 drops per minute.




SOLENOID VALVE
PRESSURE REGULATOR 2A2GG
AIR SUPPLY
AUTOMATIC DRAIN FILTER 11,200-2 (25)
MICRO-FOG LUBRICATOR 30-41-25
¼" O. D. TUBING
¼" I. D. HOSE
¼" O. D. TUBING
6 FOG OUTLETS .020 DIA. HOLES IN EACH RING

MICRO-FOG LUBRICATION SYSTEM DETAILS

Filter removes moisture and solids from air line to prevent lubricant contamination, and automatically drains collected moisture. Regulator reduces air line pressure to desired working pressure of 60 psi. Solenoid valve starts and stops Micro-Fog delivery as machine is turned on and off. Micro-Fog Lubricator creates air-borne oil fog and provides for accurate regulation of oil feed rate.

OPPORTUNITY FOR DESIGNERS

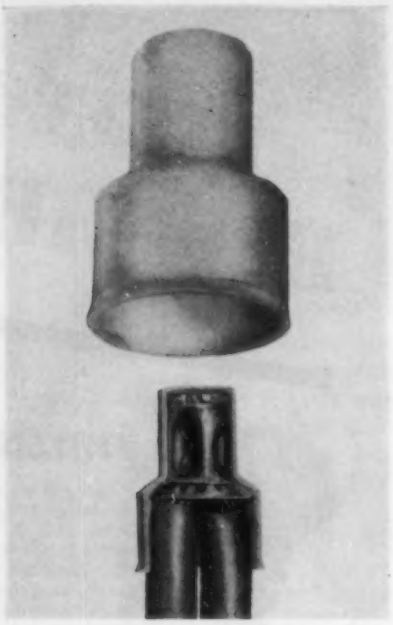
The Complete Line of Micro-Fog Lubricators provides reliable lubrication for cylinders, tools, other air equipment... bearings, gears, chains, other machine components... as well as tool lubrication on light machining operations.

For complete information, phone the Norgren representative listed in your telephone directory classified section under Norgren Pneumatic Products, or write for Norgren Blueprint MF 17.

PIONEER & LEADER IN OIL FOG LUBRICATION FOR 27 YEARS

OIL FOG LUBRICATORS
PRESSURE REGULATORS
AIR FILTERS • VALVES
HOSE ASSEMBLIES

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.



mal circuit wiring from two No. 18 wires through three No. 8 or two No. 6. They are UL-approved for building wire to 600 v and in fixtures to 1000 v, in applications up to 105 C. Buchanan Electrical Products Corp., Hillside, N. J.

For more information—
Circle 66, inside back cover

Gold-Bonded Germanium Diodes

The average forward conductance and inverse resistance of these diodes is reported to be materially greater than that of the conventional point contact design. Types such as the T9 have a forward current of over 100 ma at 1 v, with 5 megohm inverse resistance at −10 v. Peak operating currents of over 300 ma are realistic for this diode. Other diodes such as the T5 have inverse resistances greater than 1 megohm at −100 v. Transitron Electronic Corp., Melrose 76, Mass.

For more information—
Circle 67, inside back cover

High Resolution Potentiometers

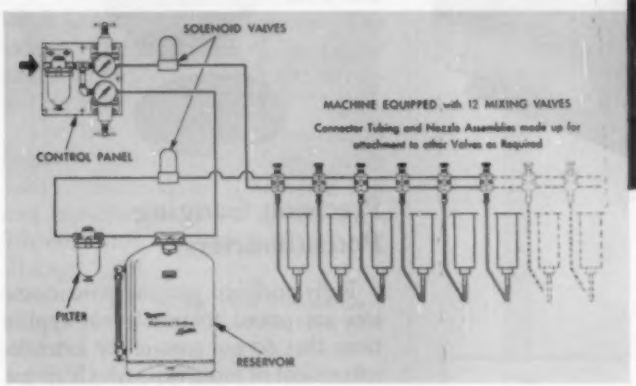
The series K-200 potentiometers are designed for low torque, high function angle applications. These 2 in. ball-bearing potentiometers are completely enclosed and can be used as single or multiple ganged units. Any

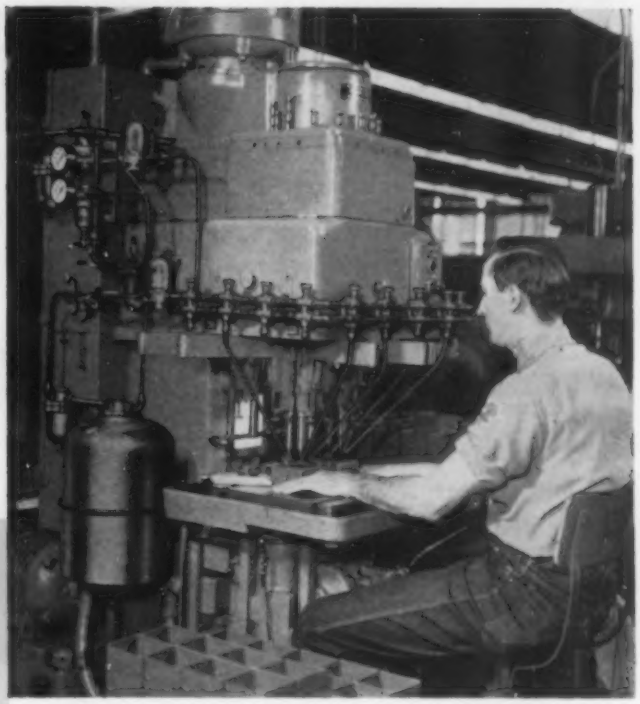
Norgren Spray-Lube System as applied by Square D Co.

to multiple tapping operation, speeds production 30%

and in addition:

- *eliminates time and labor formerly required for draining and wiping tapped parts*
- *relieves one man for more productive work*
- *elimination of flood system greatly improves working conditions*
- *substantial saving in lubricant.*


SOLENOID VALVES
MACHINE EQUIPPED with 12 MIXING VALVES
Connector Tubing and Nozzle Assemblies made up for attachment to other Valves as Required
CONTROL PANEL
FILTER
RESERVOIR



This tapping machine in the Square D Company production line handles a wide variety of tapping operations requiring as many as 12 taps in simultaneous operation. On job shown, tapping 3 holes in each of 2 switchbox covers, Norgren Spray-Lube System increased production 30%... eliminated the cleaning process. Even greater increases were reported on other jobs.

The unpleasant and hazardous disadvantages of the previous flood system, splashing lubricant over the operator and the surrounding floor, has been eliminated by Spray-Lube. Lubricant saving (Stanicut No. 107) has been substantial. Solenoid valves permit the Spray-Lube System to be actuated only when taps are approaching and contacting the work.

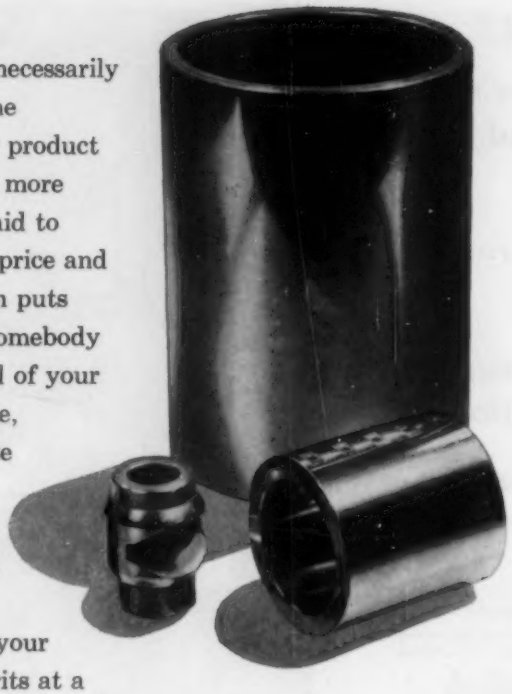
C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

For complete data on this Norgren Spray-Lube application write for Blueprint SL 5 or phone the Norgren representative listed in your telephone directory classified section under Norgren Pneumatic Products.

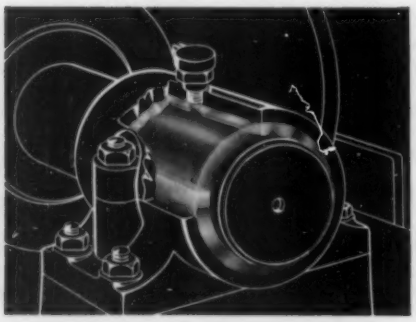
BUNTING BEARINGS

GIVE YOU

Competitive Advantages



Employment of an unnecessarily expensive bearing for the "prestige" it gives your product sometimes proves to be more of a handicap than an aid to sales. It increases cost, price and service expense. It often puts the sales emphasis on somebody else's "prestige" instead of your own. The sturdy, simple, inexpensive Cast Bronze Bunting Bearing will give you maximum bearing performance at minimum bearing cost and permit you to sell your product on its own merits at a profitable low price.



Why not re-examine your present designs. There is a Bunting engineer near you who can give you helpful technical counsel. Or write our Product Engineering Department at Toledo.

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THE BUNTING BRASS AND BRONZE COMPANY, TOLEDO 1, OHIO

BRANCHES IN PRINCIPAL CITIES • DISTRIBUTORS EVERYWHERE

practical number of potentiometer sections can be ganged on a single shaft by one-piece stainless steel clamp rings. This arrangement permits precise phasing of each unit without disassembly and independently of other units. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 68, inside back cover

Precision Ganging Potentiometers

Fully enclosed ganging potentiometers are priced for electronic applications that do not require the extended refinement of more expensive high precision types. These 3 in. independent phasing potentiometers have a power rating of 8 w. External phasing, adjustable or fixed taps and linear or non-linear resistance elements are provided. Contacts are made from precious metals. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

For more information—
Circle 69, inside back cover

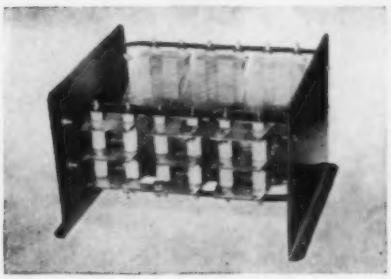
Vitreous-Enameled Resistors

A line of small, power-type resistors with axial leads, are wire-wound units with steatite cores and a vitreous enamel coating. The resistance wire

and terminal lead are both welded to the end cap.

The smallest resistor is ¼ x ⅜ in. long over-all and is rated at 3 w. Two sizes, rated at 5 and 10 w, are carried in stock in a range of resistance values. Ohmite Mfg. Co., 3678 Howard St., Skokie, Ill.

For more information—
Circle 70, inside back cover



High Current Wire Grid Resistors

A high current electrical resistor, with the resistance units formed of sturdy, self-supporting wire screen in a V shape, is said to permit expansion and contraction with only minor forces exerted on the insulators. The insulators are ceramic, maintained under slight compression so they cannot vibrate.

The new resistor is produced in complete grid bank assemblies, either open or enclosed, in 31 standard current capacities from 32 to 126 amp. Schaefer Bros. Co., 1059 W. 11 St., Chicago 7, Ill.

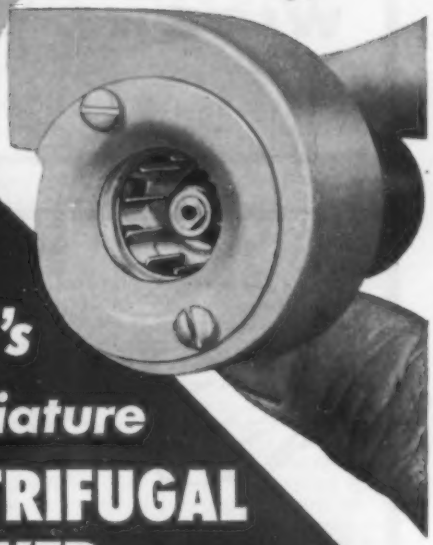
For more information—
Circle 71, inside back cover

Ceramic Feed-Thru Capacitor

A ceramic capacitor is designed with a shoulder in the body for mounting, instead of an eyelet. By eliminating the eyelet, it is said to be possible to mount the units in smaller areas, or mount them much closer together on the chassis. These capacitors will not tilt when mounted because they're self-centering. The shoulder holds each unit at the proper distance above ground, so that jigging is unnecessary. The only assembly operations needed are dropping the unit into place and soldering. These units are supplied in capacity ranges from 3 to 275 mmf at ±10 per cent and ±20 per cent toler-

as small as the tube it cools...

ACTUAL SIZE



EAD's subminiature CENTRIFUGAL BLOWER

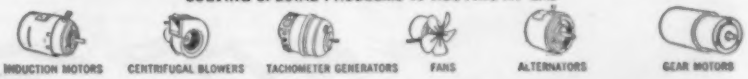
Here is the most compact centrifugal blower unit made . . . EAD's high-velocity subminiature centrifugal blower is only 2⅛" long, weighs only 6 ounces, yet it can move 13 cfm of air at a velocity of 3,000 feet per minute—and the volume holds up at high static pressures. It is driven by EAD's new one-inch diameter motor. The metal blower housing can be rotated to any position desired for maximum efficiency in cooling radar equipment, amplifier units, transmitter equipment, oscillators, and in other applications where high temperatures in confined areas demand miniaturized blowers with the highest possible performance characteristics. EAD's subminiature blower units meet all applicable MIL specification, and low temperature rise makes them suitable for high altitude and high ambient temperature operation.

CFM	13 @ 0" SP 10 @ 1.0" SP	7 @ 0" SP 5 @ 2" SP
MAX. SP.	2.5	0.6
RPM	20,000	11,000
AMPS	0.1	0.06
WATTS	10.0	6.0
CAPACITOR Mfd/Volts	0.25/220	0.1/220
WEIGHT (OUNCES)	6	6
MODEL NO.	B2GOU-C	B2HOU-C

Modifications of standard models or completely new designs can be engineered to meet your special cooling needs. Write for complete information.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



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THE FELTERS CO., 228 South St., Boston, Mass.

FELTERS S.A.E. F-13 and F-15 are grades of felt recommended for sound deadening chassis strips, spacers, dust shields and mechanical purposes when abrasion and wear are not important factors.

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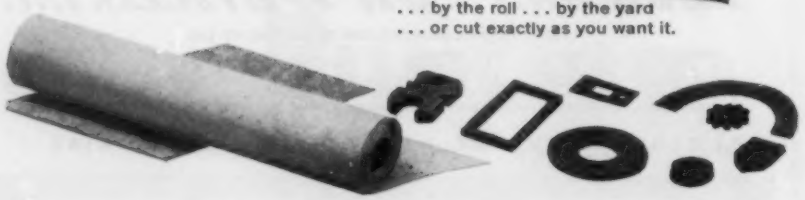
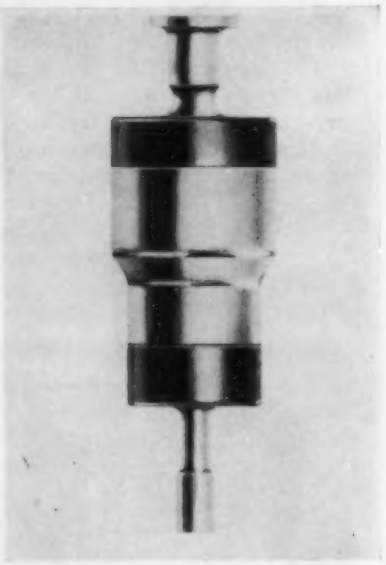
. . . by the roll . . . by the yard
. . . or cut exactly as you want it.





ances. Units are rated at 1000 v, dc. Mounting hole: 0.192 in. Solar Mfg. Corp., 46 and Seville, Los Angeles 58, California.

For more information—
Circle 72, inside back cover

Subminiature Ceramic Capacitor

The Style S-4 is readily assembled to the chassis with a ¼ in. hex socket wrench which fits the tin-plated ¼ in. hex brass base. The hot-tin-dipped terminal contains an elongated hole to accommodate more than one wire. Overall height is approximately ⅝ in. with 4-40 x ⅛ in. deep female mounting hole. A range of values from 3 to 3300 mmf can be obtained, depending on the type of ceramic material required for the application. Mucon Corp., 9 St. Francis St., Newark 5, N. J.

For more information—
Circle 73, inside back cover

Miniature Pressure Transducers

A series of miniature pressure transducers employing unbonded strain gages is available for the measurement of absolute, differential and gage pressures. No epoxy resins are employed as pressure seals, and the surface of the sensing diagram is homogenous. At 5 v excitation, dc or ac, the full scale open circuit output is 20 millivolt. The total effect of non-linearity plus hysteresis is less than ±1 per cent

Now...the spectacular new Cutler-Hammer ★★★ Unitrol

Standardized Modular Construction

All control units are 20" wide and in multiples of 14" in height. This permits easy interchange of various sizes and types of control units without rearrangement of the entire control assembly and avoids wasting space with dead panels to adapt non-uniform control units. This standardized modular construction also insures good appearance at all times because horizontal lines match.

Star studded with features that provide fastest installation or rearrangement of motor control, maximum space economy, unparalleled motor control performance and new safety for men and equipment.

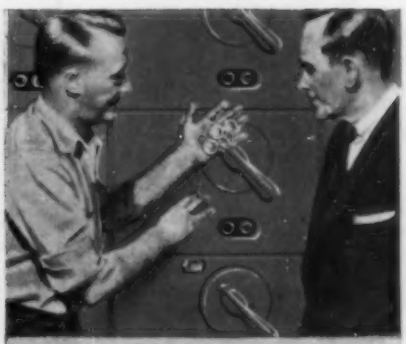
Fifteen years ago Cutler-Hammer Unitrol pioneered the idea of flexible control centers . . . the modern way to organize control equipment for better performance, greater safety, and quick rearrangement to meet industry's constantly changing control requirements. Few engineering advances ever received such enthusiastic acclaim or such rapid widespread use. Through the years there have been many imitations, but only *one* Unitrol.

Today Cutler-Hammer engineering leadership opens another new era in flexible control centers with the great new Cutler-Hammer ★ ★ ★ Unitrol. Star studded with features that permit new speed in installation, new speed in any reorganization of the equipment, more control units in less space, new safety for men and equipment and new motor control performance that simply has no equal. Whether you desire truly modern control for just a few machines, a full department or an entire factory, be *sure* you have all the facts about the new Cutler-Hammer ★ ★ ★ Unitrol before you buy. Write or wire today . . . CUTLER-HAMMER, Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
★ ★ ★
UNITROL
C-H

Unitrol Uni-Plug Saves Time

Uni-Plug automatically connects each control unit to its power supply when the unit slides into operating position. It also assures complete disconnect whenever the unit is pulled forward for inspection or attention. All units can be locked in "disconnect" position. Unitrol Uni-Plug thus saves wiring and rewiring time—and insures safety.



Self-Aligning Disconnect Operators

Unitrol control units can be equipped with either fused disconnect switches or circuit breakers. Both types have self-aligning three-position operators which are arranged for padlocking with as many as three locks in "off" position.

The name UNITROL is a Cutler-Hammer trade mark.

New C-H Three-Star Control Units

New Superlife Vertical Contacts end care and costs for all time in normal control uses. Adjustable Load Sensing Coils with 3% overload accuracy (compared to usual 12%) permits motors to work harder safely. Full 3-Phase Protection now costs as little as $6 (list price) additional per control unit. Compare this with the cost of just one motor burn-out.

GEAR PROBLEMS? —Check with FAIRFIELD!

IF you use gears in the product you make, we believe it will pay you, as it has others, to become acquainted with FAIRFIELD—the place where fine gears are produced to meet your specifications EFFICIENTLY, ECONOMICALLY! Fairfield's production facilities are unexcelled for making all kinds of accurate, automotive type gears such as are now finding wide use in all branches of industry: for Tractors, Trucks, and Buses . . . for Agricultural Implements . . . for Machine Tools. Ask for latest literature describing Fairfield's facilities. *Your inquiry will receive prompt attention.*

Fine Gears Made to Order

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(*Fellows Type*). Sizes from 1½" to 15".

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

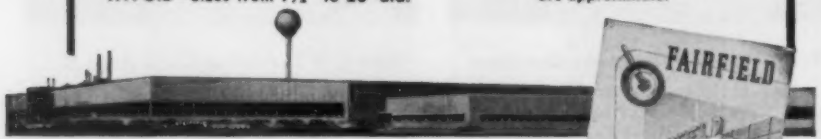
ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 52". Diameters from 1" to 6".

DIFFERENTIALS—10,000 to 300,000 inch pounds capacity.

Note: All of the sizes above are approximate.



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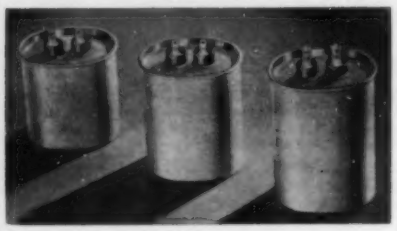
of full scale. The sensing diaphragm may be exposed directly to the pressure media where flush mounting is required, or interchangeable adapters are offered to convert the basic instrument into a chamber-type pressure transducer. Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 65, Calif.

For more information—Circle 74, inside back cover

Polystyrene Capacitors

High stability capacitors using polystyrene dielectric are now available in 200, 400 and 600 v units with capacities ranging from 0.05 to 25 mfd. The temperature operating range is −80 C to 75 C, with no voltage derating to 75 C. Corson Electric Mfg. Corp., 540-39 St., Union City, N. J.

For more information—Circle 75, inside back cover



Drawn Oval Capacitors

Available for 236, 330 and 440 v, ac, 60 cps, all sizes of these capacitors are made in seamless cases. No solder is needed or used. Cases are filled with chlorinated diphenol resin. This impregnant is non-flammable. Three terminal types are provided: quick-connect type, the eyelet and fork types, and each available for conventional or barrier type terminal mounting. Potter Co., 1950 Sheridan Road, N. Chicago, Ill.

For more information—Circle 76, inside back cover

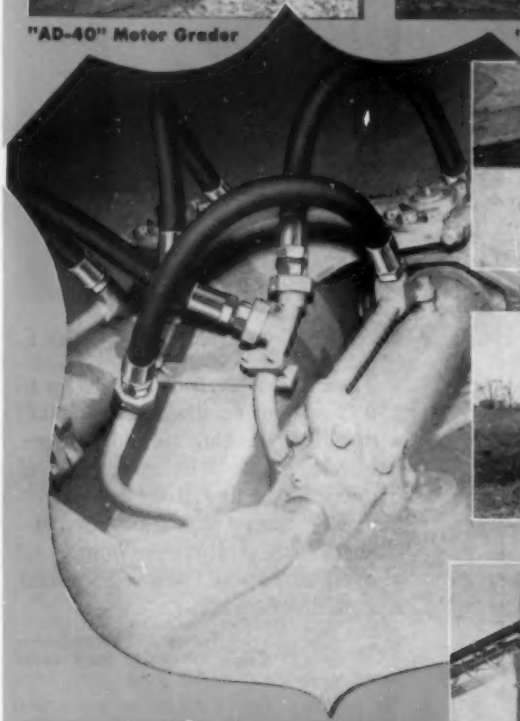
Dipped Mica Capacitor

A miniature capacitor with parallel leads is available in capacities up to 5100 mmf at 300 v, dc, and up to 3900 mmf at 500 v, dc, with operating temperatures up to 125 C. Performance characteristics of the DM-20 in the lowest and highest capacities are better than the characteristic C limit throughout temperature ranges from

Eastman HYDRAULIC HOSE ASSEMBLIES DELIVER MOBILE POWER *for* ALLIS-CHALMERS

"AD-40" Motor Grader

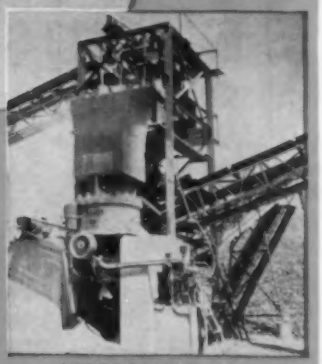
"TS-300" Motor Scraper



Eastman Hydraulic Hose Assemblies used on steering ram of Allis-Chalmers TS-300 and TS-360 Motor Scraper. Also used on TS-200 Series to control steering, plus apron, ejector and bowl action—applying down pressure when loading equal to the weight of the scraper—38,560 lbs.!

ALL-CROP Harvester

"WD-45" Tractor



HYDROCONE Crusher

GLACIERS NEVER HAD IT SO EASY . . .

The millions of years required by the glaciers to scour and alter the earth diminish to mere minutes when Allis-Chalmers earth moving and grading machinery go to work. Many of these mighty machines owe much of their ease of operation and maneuverability to hydraulic power—delivered through **EASTMAN** Hydraulic Hose Assemblies.

TODAY'S FARM YOUTH NEVER BORN "30 YEARS TOO SOON"

Milestones in farm mechanization are marked by Allis-Chalmers farm machinery. Pioneering in many farming innovations resulted in such exclusive firsts as the ROTO-BALER, ALL-CROP Harvester, Rear-Engine Tractor—Power Shift Wheels, SNAP-COUPLER and Hydraulic Traction Booster. Much of the operation and control of this world famous line of farm machinery is done through hydraulic power—also applied through **EASTMAN** Hydraulic Hose Assemblies.

NATURE NEVER CRUSHED ROCK LIKE THIS . . .

Hydraulic power on the HYDROCONE crusher affords "one man, one minute" product size control. It provides a rapid and convenient means of raising or lowering the crushing head. It permits compensation for wear and facilitates emptying the crushing chamber in case of power failure or for the quick release of uncrushable materials. Allis-Chalmers pioneered in this type of crusher—as **EASTMAN** pioneered in Hydraulic Hose Assemblies.

TURN TO EASTMAN for *your* Hydraulic Hose Assemblies, too. Whatever your requirements, always get your first recommendation from **EASTMAN** . . . *first in the field.* Exclusive designs, advanced engineering, unequalled production facilities and efficiency—mean unequalled economy, performance and constant customer satisfaction for you.

Eastman *first-in-the-field*

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

EASTMAN MANUFACTURING CO.
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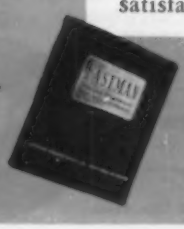

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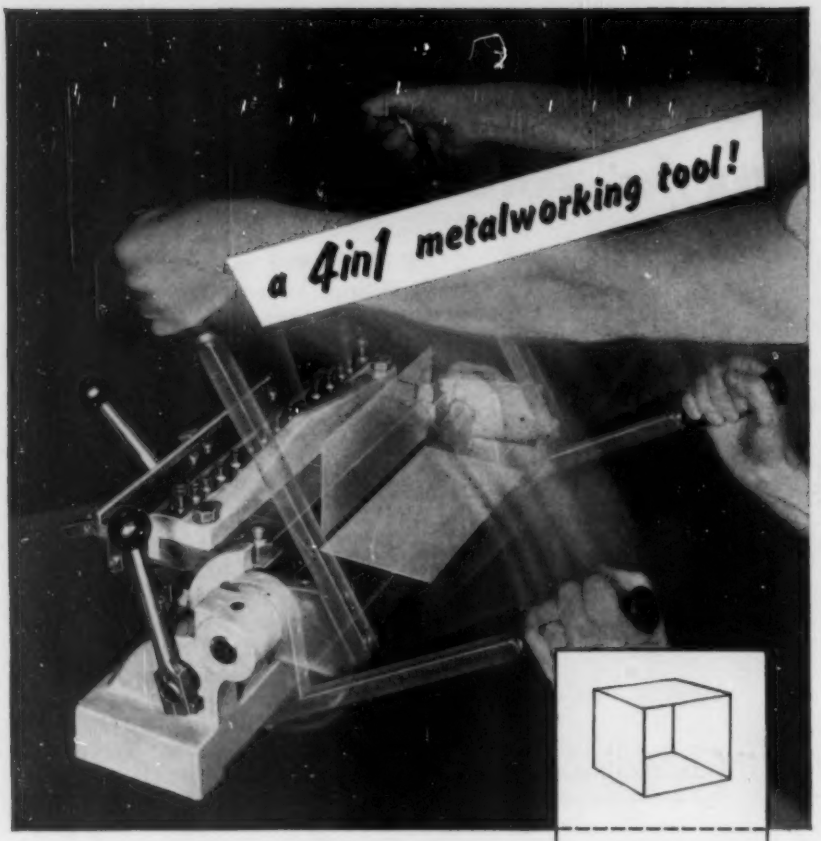

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- Open End Brake
- Standard Brake
- Bar Folder

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A number of forming jobs can be done with the Di-Acro Box Finger Brake, by simply adjusting or changing the type mounting bar on the contact surface. Di-Acro Finger Brake is:

1. A Box and Pan Brake — when equipped with a complete set of Box Fingers.
2. An Open End Brake—when Open End Finger is installed in place of Box Fingers.
3. A Bar Folder—when an Acute Angle Bar replaces the Box Finger Bar mounting.
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Di-Acro Standard and Radius Brakes are also available. Ten models in all.

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"DIE-LESS DUPLICATING"

di-acro PRECISION METALWORKING MACHINES

O'NEIL-IRWIN MFG. CO. 333 8th Ave., Lake City, Minn.

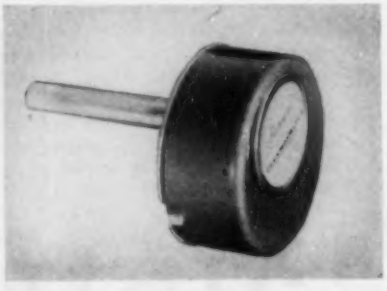
—55 C to 125 C. Dimensions of this phenolic-coated capacitor are ¾ x 7/8 x 7/8 in. thick. Electro-Motive Mfg. Co., Inc., Willimantic, Conn.

For more information— Circle 77, inside back cover

Capacitors Operate to 150 C

These capacitors will operate up to 150 C without derating and to 200 C with proper derating and adjustment. Available in a wide selection of hermetically sealed tubular and rectangular cases with glass-to-metal closures for positive environmental protection. Astron Corp., 255 Grant Ave., E. Newark, N. J.

For more information— Circle 78, inside back cover



Thermostats Based On Building-Block Principle

For accurate temperature control and overheat detection at heavy electrical loads up to 20 amp, a local-bulb snap action thermostat can be fitted to the operating conditions and mounting requirements of an individual application. Various combinations of head styles and mounting arrangements for

use in gases, liquids or solids in many types of equipment are available.

The user selects from three temperature ranges (50-300, 0-250 F −50 F to 200 F) and six types of snap switches. The basic sensing bulb of the series is ⅜ x 3½ in. long. Fenwal, Inc., Ashland, Mass.

For more information—
Circle 79, inside back cover

Power Actuator

A power actuator with a driving force of 55 lb, originally designed as an aircraft bomb shackle release, is said to be of value as an emergency device. It can be actuated by an 80 w impulse, the actuator delivering its punch in a stroke of 1½ in. Possible commercial applications include remote closing of pipe line valve when a sudden pressure drop indicates a leak, cutting off high voltage power systems when overloaded.

Weighing slightly less than 2 lb, the actuator is 3¼ x 1⅛ in. dia. New Haven Clock & Watch Co., 140 Hamilton St., New Haven, Conn.

For more information—
Circle 80, inside back cover

Precision Tape Feed Assembly

The capstan and all other precision elements in the tape feed path of this recording device are mounted on one rigid base plate. This plate is in turn shockmounted to the top plate of the recorder. The recorder unit will store up to 28 tracks of information on 1¼ in. tape. It has tape capacity for 40 min of recording at a speed of 10 in.

AXIAL BLOWER

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per sec, when using tape of conventional thickness. Play time can be extended by using thinner tapes and reducing tape speed.

The recorder detects its own malfunctioning. A single track data-monitor head readily detects such mechanical failures as broken tape, improper tracking, failure of the pinch rolls to close, failure of uniform tape motion, or end of the tape. Electronic failure is also readily detected. In any of the above situations, an indicator light warns the operator at local and remote control stations. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

For more information—
Circle 81, inside back cover

Woven Heater Elements

Of the various materials used for insulating these tailor-made units, neoprene rubber is suggested where medium heat (200 F) is involved. Silicone rubber is recommended by the maker where higher heat is in demand. For long periods it has excellent stability and flexibility through a temperature range of −80 F to 500 F without deterioration. Safeway Heat Elements, Inc., Middletown, Conn.

For more information—
Circle 82, inside back cover

Oil-Tight Indicator Lights

The design of these pilot lights provides for retained oil-resistant gaskets. Glass lenses in several shapes are avan-

able with omnidirectional light spread. Discs (with words, letters, or numbers) can be inserted behind flat glass lenses to deliver specific messages. A range of incandescent lamps, with screw or bayonet base, as well as several neon types are accommodated. Mounting is possible in either 1⅛ or 1 in. clearance holes. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

For more information—
Circle 83, inside back cover

Sub-Miniature Radio Noise Filter

This filter, consisting of four 0.5 mfd capacitors and two 0.5 mh toroids, is rated at 2 amp, 200 v, dc. It is ⅞ x ⅞ x 1⅛ in. and weighs ¼ oz. Dielectric is epoxy resin, which permits operation at 300 F. Compression glass-to-metal hermetic seals are provided. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

For more information—
Circle 84, inside back cover

Measures Pulsating Fluid Flow

This flowmeter can be used with all types of fluids, including corrosive liquids, at line pressures up to 2000 psi, and is especially suitable for heavy-duty industrial applications. The unit is said to eliminate the dynamic errors found in more conventional flowmeters and permits the accurate measurement of either average or instantaneous flow at rates up to 8 gpm in a 1 in. dia line.

The new flowmeter employs an

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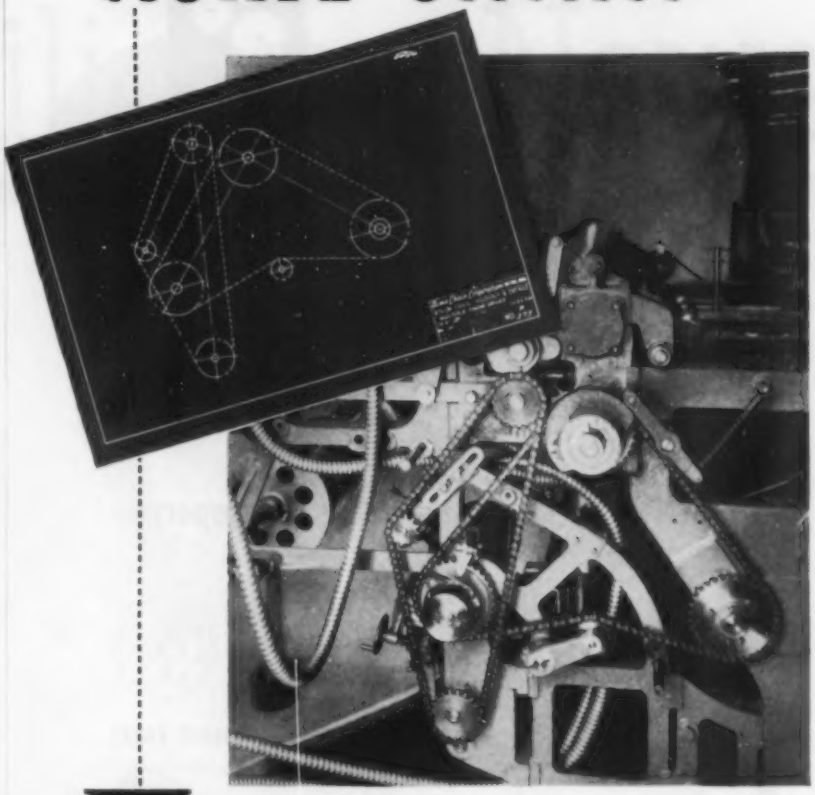

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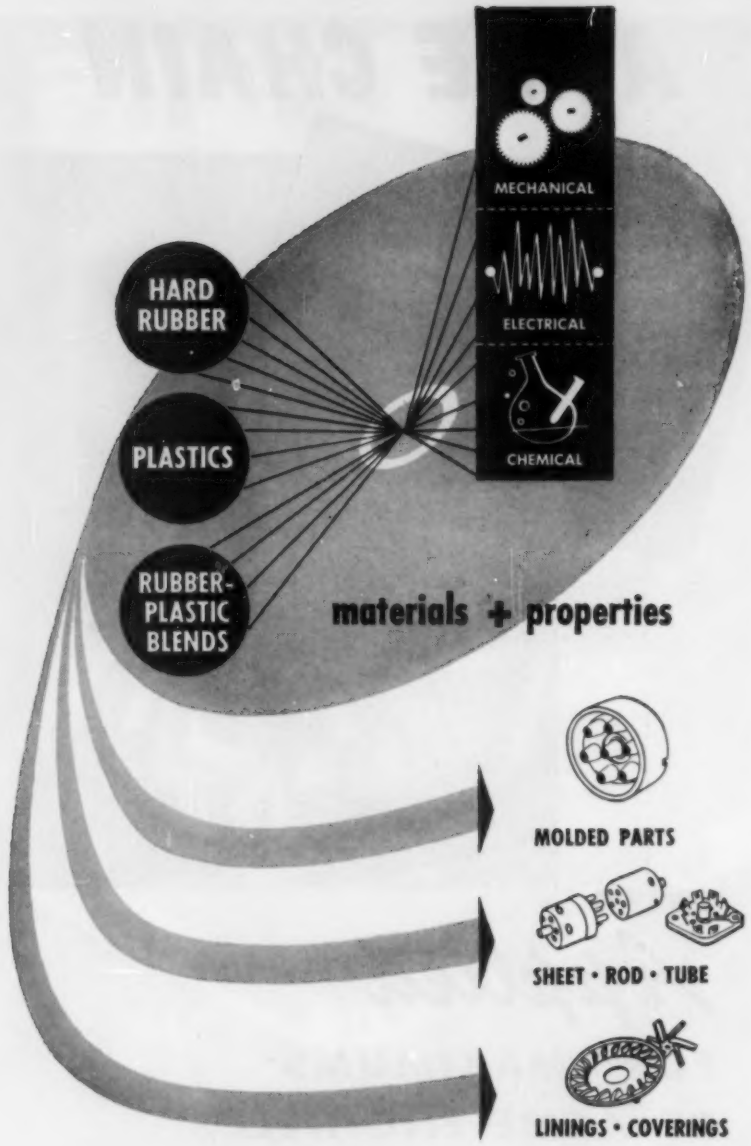

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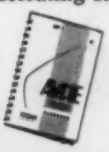

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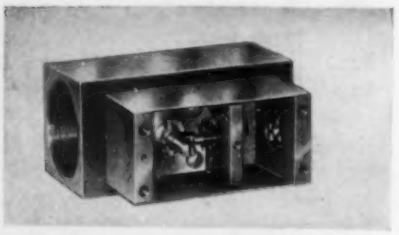


orifice plate perforated with sixteen ⅛ in. holes and mounted on a hinged support inside a section of conduit. Fluid flow pressure acting upon the orifice plate is transmitted through a special force-transmitting seal to the force-sensing, strain-gauge element of a pressure transducer. The perforated design of the orifice plate minimizes the disturbance of flow in the conduit and results in a more accurate force indication to the transducer. This meter's sensing element operates with a-c or d-c excitation voltages of 6, 12 or 15 v, with bridge resistances of 350, 600 or 800 ohm, and minimum full-scale outputs of 20, 40 or 50 millivolt, respectively. Dynamic Instrument Co., Inc., 28 Carleton St., Cambridge, Mass.

For more information—
Circle 85, inside back cover

Adjustable Machine Control Arm

This control arm provides a flexible method of positioning the "run" and "stop" buttons on presses. It conserves operator time and motion and promotes safety by permitting the operator to place the press "run" and "stop" by buttons at the most convenient and safest operating position.

The control buttons are mounted on a bar attached to an adjustable telescoping arm. Telescoping shafts permit any desired height adjustment. Major movements front to back and

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 19

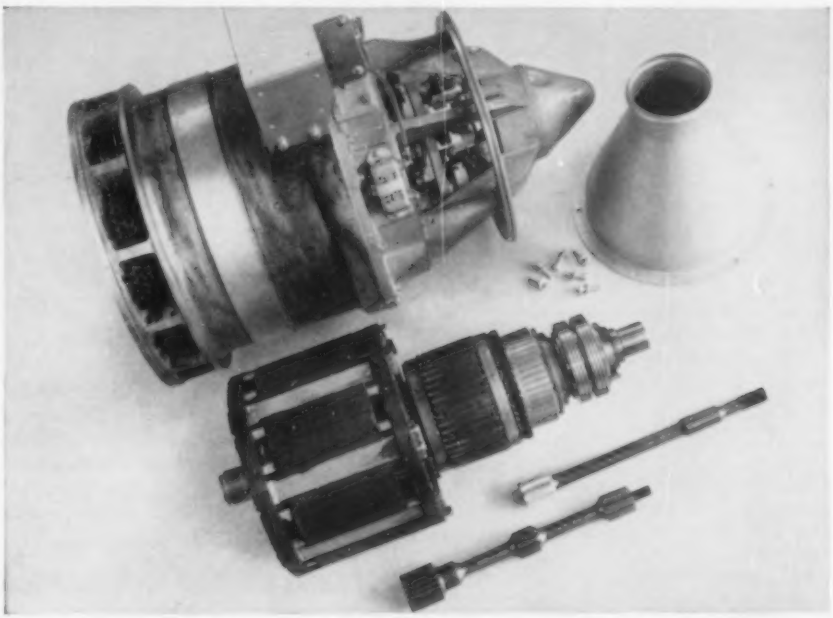
Silicone Fluid Used to Obtain More Uniform Gage Response

While the viscosity of most fluids changes with temperature, Dow Corning 200 Fluids have relatively flat viscosity-temperature slopes. This characteristic plus nonvolatility and excellent resistance to oxidation and mechanical shearing make these silicone fluids ideal for use as damping and hydraulic media in such devices as the dairy homogenizer pressure gage manufactured by Taylor Instrument Company.

Initially, the hydraulic system used to translate volumetric pressures into the pinion-and-sector gear that controls the dial indicator of the gage, contained a glycerine and water solution. But the viscosity of the solution varied with changing temperatures causing the response time of the gage to vary accordingly.

After an adjustable orifice installed in the hydraulic system failed to solve the difficulty, Taylor engineers replaced the troublesome water solution with a Dow

(cont'd on pg 2)



OVEN-HOT AIR USED TO COOL SILICONE INSULATED EQUIPMENT

Cool electrical equipment with air that has a temperature of 250 F? Yes you can, providing the equipment is protected with Dow Corning silicone insulation. Here's how Westinghouse engineers put 250 F air to work cooling their new 40 kva, 400 cycle alternators or generators for jet planes.

When a jet plane is hurtling through low altitude atmosphere at the speed of sound, air available for cooling purposes may have a temperature as high as 250 F. Far from cooling organic electrical insulating materials, these high ambients cause them to burn up in short order. At high altitudes, air temperature drops to —70 F, but the air is so thin, it has less heat-absorbing power than at low altitudes.

That's why Westinghouse uses silicone (Class H) insulation in their jet plane alternator. Operable at temperatures in the range of 480 F and higher, the silicone insulation is actually cooled by air hot enough to cause rapid failure of ordinary insulating materials.

To provide maximum cooling effect at any altitude, the Westinghouse alternator is fitted with a cone and hood combination that directs air to the critical pole and rear bearing areas. Because of its exceptional oxidation resistance and thermal stability, another silicone product, Dow Corning 44 Grease, is used to lubricate the bearings.

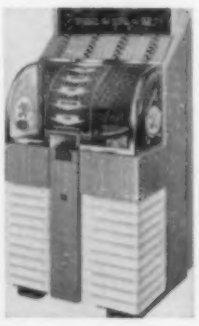
No. 188

Silicone Grease Used in Juke Box

The effectiveness of most organic greases is greatly reduced by unusually high or low temperatures. That is why semi-inorganic Dow Corning 44 Grease is the specified lubricant for the popular 80 record juke box produced by AMI Corporation of Grand Rapids. Applied to the exposed moving parts of the music machine, this silicone lubricant withstands temperatures ranging from —40 to 350 F, assuring proper lubrication and trouble-free operation of installations in any climate.

Dow Corning 44 Silicone Grease has proved to be such an effective lubricant for this particular application that it has now become a standard practice for every AMI repairman to carry a tube in his regular repair kit.

No. 187



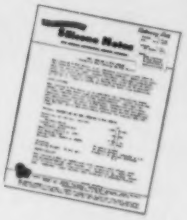
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Sylkyd 1090 Wire Varnish, a new and improved modified silicone bonding agent for glass served wire, provides a stronger bond to the conductor; is more flexible; has better scrape resistance, outstanding oil resistance and greater heat stability than most modified silicone wire varnishes. *No. 192*

Parting agent in shell process of metal casting, Dow Corning F-496 is an easy to use solvent solution of high viscosity silicone fluid. A single application gives easy release of several resin-sand shells, and leaves no carbonaceous build-up. *No. 193*

"What's a Silicone?" is the title of a 32-page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 194*

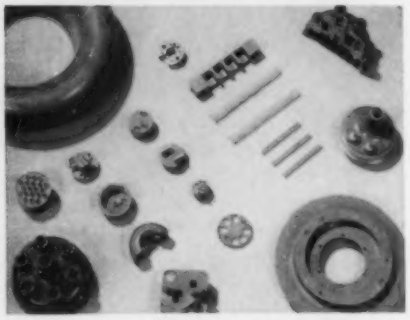
Silicone Rubber Sealed Low Temperature Switches, reprinted from ELECTRICAL MANUFACTURING, reviews currently available variations; aids in selecting the type most suitable for a particular application. *No. 195*

Recently revised listing of manufacturers of silicone (Class H) insulating components is now available. Designers and builders of electric machines and electronic equipment may want to refer to these Sources of Supply. *No. 196*

Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design engineers. *No. 197*

New Silicone Molding Compound Offered for High Temp Parts

Dow Corning 301 Molding Compound is a new glass-filled silicone compound developed for molding plastic parts which will withstand continuous exposure to 450 F and intermittent exposures to temperatures of 700 F and higher.

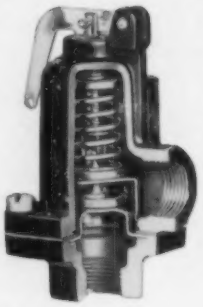


Typical properties of 301 fabrications after molding for 10 minutes at 340 F include: tensile strength of 5,000 to 7,000 psi; compressive strength of 10,000 to 12,000 psi; and impact strength of 15 to 22 footpounds per inch. Flexural strength ranges from 12,000 to 14,000 psi at room temperature and 5,000 psi at 392 F.

These properties suggest the use of 301 Molding Compound for a wide variety of high temperature structural or dielectric parts for aircraft, electrical and electronic equipment. The new compound may be molded with conventional equipment by either compression or transfer techniques. Parts may be pulled hot without cooling, and after-baking is unnecessary except where the parts are to carry a load at high temperatures. Mold shrinkage ranges from zero to 0.0035 percent. Finished parts may be machined with high speed tools. *No. 189*

Dependable Valve Operation Assured With Silastic Seals

Relief valves for hot water must: open accurately at set pressure; close, drip-tight, at the slightest reduction from that pressure; give long reliable service. That's a difficult order but with heat-stable Silastic*, McDonnel & Miller, Inc. of Chicago have engineered such maximum dependability into their new No. 230 series of pressure relief valves.



Because it has excellent resistance to moisture and to compression set at high temperatures, Silastic is ideal for sealing these devices. In the words of McDonnel & Miller, "the compressibility of Silastic provides good closure, its high temperature stability guards against deterioration, and Silastic resists adhesion, thus providing dependable operation." *No. 190*

*T.M. DOW CORNING CORPORATION

SILICONE FLUID *(Con't from page 1)*

Corning 200 Fluid. Showing very little change in viscosity at operating temperatures ranging from 50 to 100 F, the silicone fluid keeps the gages operating uniformly in any dairy without further readjustment.

Taylor also uses two silicone compounds in the gage to assure accurate, dependable service. One of these materials, applied to the pinion-and-sector movement, dampens vibration and greatly lengthens gear life. Dow Corning 11 Compound is coated on the O-ring sealing the faceplate to prevent moisture from entering and fogging the glass. *No. 191*

Dow Corning Corporation, Dept. 8609, Midland, Michigan

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left to right are made by swinging the arm to the desired position on its universal ball joint connection. Although the unit is permanently mounted on the press, the arm can be swung completely clear of the working area when changing dies, and can be instantly relocated when production is resumed. Danly Machine Specialties, Inc., 4358 W. Roosevelt Road, Chicago 50, Ill.

For more information—
Circle 86, inside back cover

Microminiature Cable

Microminiature coaxial cable, said to be distinguished by low capacitance, has an OD of 0.132 in. max. Characteristic impedance is 98 ohm. A thin wall of nylon under the braid permits soldering both center conductor and braid. Temperature rating is −65 F to 120 F. Microdot, 1826 Fremont Ave., S. Pasadena, Calif.

For more information—
Circle 87, inside back cover

Silicon Voltage Reference Diodes

Four types of silicon diodes with reverse breakdown voltage (measured at 5 ma), ranging from 3.7 to 8.0 v have breakdown voltage temperature coefficients from −55 C to 150 C. Hermetically sealed in miniature cans, total power dissipation for the new reference diode types is 150 mw at 25 C and 40 mw at an ambient temperature of 150 C. Maximum average rectified forward current ranges from 90 to 125 ma at 25 C. Maximum reverse current is 0.1 microamp at −1 v at 25 C. Texas Instruments, Inc., 6000 Lemmon Ave., Dallas, Texas.

For more information—
Circle 88, inside back cover

"Thin-Package" Linear Actuators

Coverage of the 0 to 7,000 lb operating-load range with a line of "thin-package" linear actuators has been announced.

Typical envelope sizes are 1.8 x 3.7 in. for the 413 series, 2.6 x 4.9 in. for the 434 series, and 3 x 5 in. for the 435 series. Representative weights are 1.7, 5, and 9.9 lb re-

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NP Power Drive Cylinder

This cylinder has *all* the *most wanted* design features . . . provides exceptional adaptability, quick assembly and disassembly. You can make *many* fast change-overs using the simplest tools. Cushioning is easily adjusted; packing and internal parts can be changed; operation modifications can be made quickly on the *basic* cylinder.

No other cylinder offers so many vital features: compact, streamlined design; lightweight aluminum alloy and steel construction with *no* sacrifice of strength; sealed-in lubrication which eliminates need for external line lubricators. Operates with air, water or oil without interchanging or adding parts.

RATINGS: air — 200 psi; water or oil — 500 psi; Bore diameters: 1½", 2¼", 3", 4". Mountings: foot, flange, pivot, clevis, trunnion

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A control console incorporates all operating controls, and associated monitoring and cycling equipment. Switch selected inputs consist of single frequency, sweep cycling or complex waveform signals. Special features include a dual beam 'scope for comparing input and Shaker table acceleration signals, and five adjustable circuits to compensate for decrease in transfer function (g output/volts input) as frequency increases.

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spectively. These specifications vary with application requirements.

Typical maximum operating loads, maximum static loads, and ultimate static strength in tension and compression are, respectively, as follows: 500, 1300, and 2,000 lb for the Series 413; 2,000, 5,000 and 9,000 lb for the Series 434; and 7,000, 10,000, and 15,00 lb for the Series 435. Voltage requirements are standard 26 v, dc; 115 v, single-phase, 400 cps, ac; or 200 v, three-phase, 400 cps, ac. Lear, Inc., Grand Rapids, Mich.

For more information—
Circle 89, inside back cover

Surface Speed Indicator

This tachometer rides a roller drum or other moving surface to indicate continuously and instantaneously the rate of speed and changes of speed of moving materials such as textiles, plastics, paper, metal and fabricated products of all kinds. The dial will read directly in feet or yards per minute or feet or yards per hour. Instruments can be furnished with a built-in counter to simultaneously give the total number of yards or feet produced.

A variety of ranges can be supplied, covering speeds as slow as 5 fpm and as high as 2400 fpm, and in yards as low as 2 ypm and as high as 600 ypm. Herman H. Sticht Co., Inc., 27 Park Pl., New York 7, N. Y.

For more information—
Circle 90, inside back cover

High Frequency Ignition

In a recently introduced ignition system, the interrupted primary current normally dissipated through the condenser in conventional circuits is converted into high frequency oscillations and fed back into the secondary by means of a Tesla coil. The result is a simple unit that can be installed on any type of internal combustion engine in place of the slightly smaller conventional ignition coil.

Benefits of this high frequency system are said to include better combustion even with leaner mixtures and reduced carbon formations, preconditioning and activation of mixture, higher ozone generation, current density "spread" over plug and breaker

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A positive photographic intermediate is produced *directly* by exposing-the "paste-up" in contact with Kodagraph Autopositive Paper, then processing the print in standard photographic solutions. No negative step . . . *easy room light operation.*

New design is added to the Autopositive, which has dense photographic black lines on a clean white translucent base. Required number of shop prints—each crisp and uniform—are produced from this master, which can also be used later on for minor revisions.

Kodagraph Autopositive Paper

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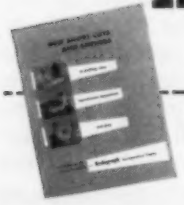

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Proper Design in Welded Steel is *Always* Lower in Cost

Material Cost is Less—It's a fact . . . steel is three times stronger than iron, two and a half times as rigid. Where strength alone is needed, one-third the metal is necessary. When rigidity is important, less than half the material is required. But steel costs only one-third as much per pound. Steel is more easily placed where it can carry more load per pound of metal. As a result, ultimate savings with steel are limited only by the resourcefulness of the designer.

Manufacture is Simpler—Fewer manhours . . . simpler, less costly production tools are needed to manufacture products from steel. By proper design, many operations needed for machining castings can be eliminated entirely. Assembly operations can be simplified . . . finishing and cleaning manhours reduced substantially.

Products designed in steel have a modern appearance to improve selling appeal while reducing costs on an average of 50% according to field reports.

Welded Design Saves 50% *on motor gear housing. Original cast construction weighed 175% more . . . required 90% more machining.*

Cost Down 57% *on machine stand by change to welded steel. Also eliminates former milling and drilling on former castings.*

HOW TO START A COST REDUCTION PROGRAM

Your Lincoln Representative is a specialist in welded design. We will gladly assist your engineers in restudying designs to determine where and how welded steel can save an average of 50% in the manufacture of your products. Call or write.

Design Bulletins also available to product engineers by writing on your letterhead to

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points, radically improved ability to fire oil and carbon-fouled plugs. Results in increased horsepower, lower fuel consumption, smoother idling, positive starting under all conditions. Holthouse High Frequency Ignition, Inc., 1243 W. Belmont Ave., Chicago 47, Ill.

For more information—
Circle 91, inside back cover

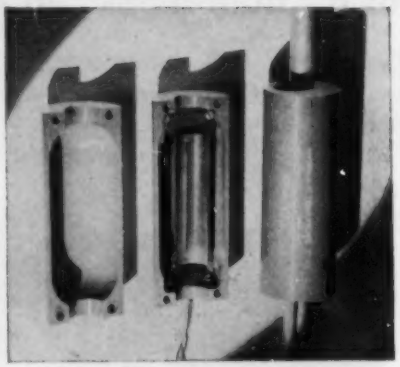
Subminiature Centrifugal Blower

This unit is 2⅞ in. long and weighs less than 6 oz. Designed and tested for high altitude and high ambient operation, it meets all applicable MIL specifications. Available in either rotation and in single or double-ended models, air delivery of the single ended blower

is 13 cfm at 0 in. static pressure (20,000 rpm) and 7 cfm at 0 in. static pressure (11,000 rpm). Velocity of the 20,000 rpm model is 3,000 fpm. A 1-in. dia motor is used, available in single or three-phase for 400 cps or variable frequency operation. Eastern Air Devices, Inc., 381 Central Ave., Dover, N. H.

For more information—
Circle 92, inside back cover

FLUID POWER AND CONTROL



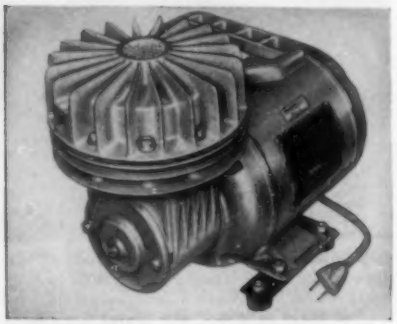
Hydraulic Temperature Probe

Temperatures can be measured with this probe anywhere in a hydraulic network without disturbing the operation of the system. You do not have to drain the system or break lines or add fittings. Place the probe around the hydraulic line at any point.

The split cylinder casting thermally isolates that section of the line while within the cylinder a spring loaded saddle is brought to bear against the line wall. This saddle contains the temperature-sensitive high resistance element. These probes are wound at 20,000 ohm so that when they are used in bridge circuitry, high outputs can be obtained even for relatively small changes in temperature.

The Series 8000 probes are made in all sizes to fit hydraulic lines of all diameters, and they can be used to measure temperatures across the range of −100 F to 500 F. Arnoux Corp., Dept. PG-3, Box 34628, Los Angeles, Calif.

For more information—
Circle 93, inside back cover

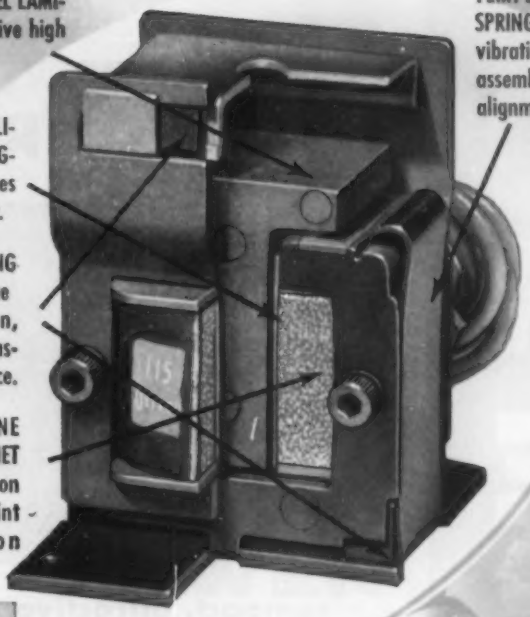


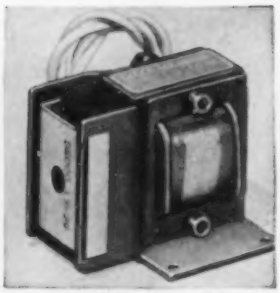
Portable Compressor For Pneumatic Equipment

A self-contained, portable air compressor for powering pneumatic devices where piped compressed air is not available plugs in to any 110 or 220 v, a-c line, delivers up to 100 psi pressure and 3.5 cfm free air. No tank or safety valve is required. Sealed ball bearings are used throughout, with no lubrication needed.

Overall length is 13 in. overall height, 10 in. weight, 40 lb. Unit is

the "inside" story!

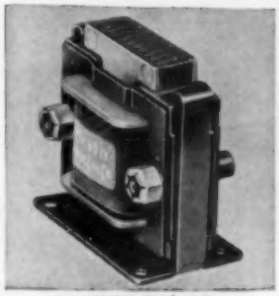

SILICON STEEL LAMINATIONS—give high efficiency.
HARDENED BERYLLIUM COPPER PLUNGER GUIDE — reduces friction and wear.
SHOCK - ABSORBING BUMPERS — reduce self - destruction, cushion stroke, assure longer service.
HEAVY SILICONE INSULATED MAGNET WIRE — wound on high flow point - molded nylon bobbin.
TEMPERED STEEL SPRING — absorbs vibration — holds assembly firmly in alignment.



HORIZONTAL PUSH-TYPE WELDED BASE

VERTICAL PULL TYPE SHOCK-MOUNTED

VERTICAL PUSH-TYPE WELDED BASE



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2435 HILTON ROAD, FERNDALE 20, MICHIGAN

REEVES

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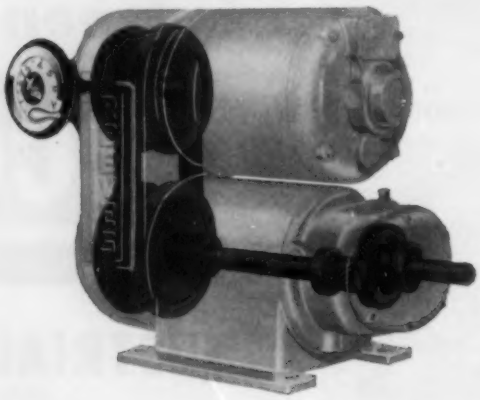
fractional HP Vari-Speed MOTODRIVE

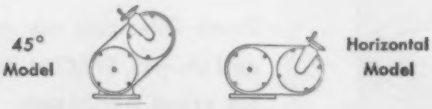
compact, attractive design

Within streamlined, metallic blue housing is REEVES' "weatherized" motor, time-tested speed changing mechanism, and heat-treated helical gear speed reducer. Maximum space for vertical model only 16 5/16" x 21½" x 11½". Other models equally compact.



simple, accurate operation

14-turn handwheel on Speedial indicator gives you stepless, accurate speeds from 3 to 4660 rpm's—within a 2:1 to 10:1 speed range. Electric remote or automatic controls also available.



versatile application

Select your *exact* needs from 112 assemblies: ¼, ½ or ¾ hp. units; horizontal left or right, vertical, or 45° left or right models; horizontal or vertical down output shaft.

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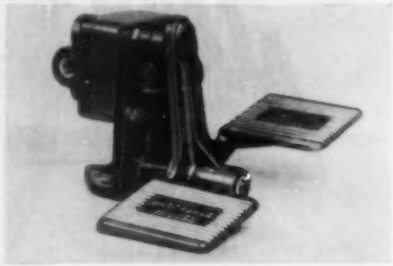
REEVES PULLEY COMPANY • Columbus, Indiana
Division of RELIANCE Electric and Engineering Co.

complete with built-in intake filter; has ⅛ hp motor equipped with capacitor, overload protector and UL-approved cord and plug. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information—
Circle 94, inside back cover



Foot-Operated Valve

A four-way, foot-operated air valve is for the shop air range, up to 250 psi. Any port may be used as the pressure port. For most convenient piping, the valve body can be rotated in 90 deg increments. A mounting bracket is an integral part of the valve.

The new valves are of brass, the rotor of bronze. The shaft and detent ball are stainless steel, the valve body and housing are aluminum. The valves are available in ¼ and ⅜ in. port sizes. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

For more information—
Circle 95, inside back cover

Adjustable Combination Bypass and Restrictor

These flow regulators are designed to maintain a constant regulated flow when pump output varies or is greater than required for part or all of the system. In addition to the constant adjustable regulated flow, the design provides additional flow from the bypass port that can be used for operating other parts of the hydraulic system. Also these regulators can be connected in series to provide additional regulated circuits from one pump or power source.

Over-speeding of the controlled circuit when pressure at the bypass port is high is prevented by the restrictive design feature. Flow can be regulated from ½ to 7½ gpm and will not vary more than ±5 per cent as long as fluid specifications are not materially

Relay Frame made by Madison-Kipp for Westinghouse Air Brake Company, Union Switch and Signal Division.

ADDED DESIGN POWER with MADISON-KIPP zinc and aluminum die castings

Your design problems require your own special talents. Die casting is a unique art in which Madison-Kipp mechanics are seasoned and skilled. By combining these talents the resulting design power is raised to a high degree.

The difficult die casting with 2 steel inserts here illustrated was developed and produced with the close cooperation of the user and the die designer.

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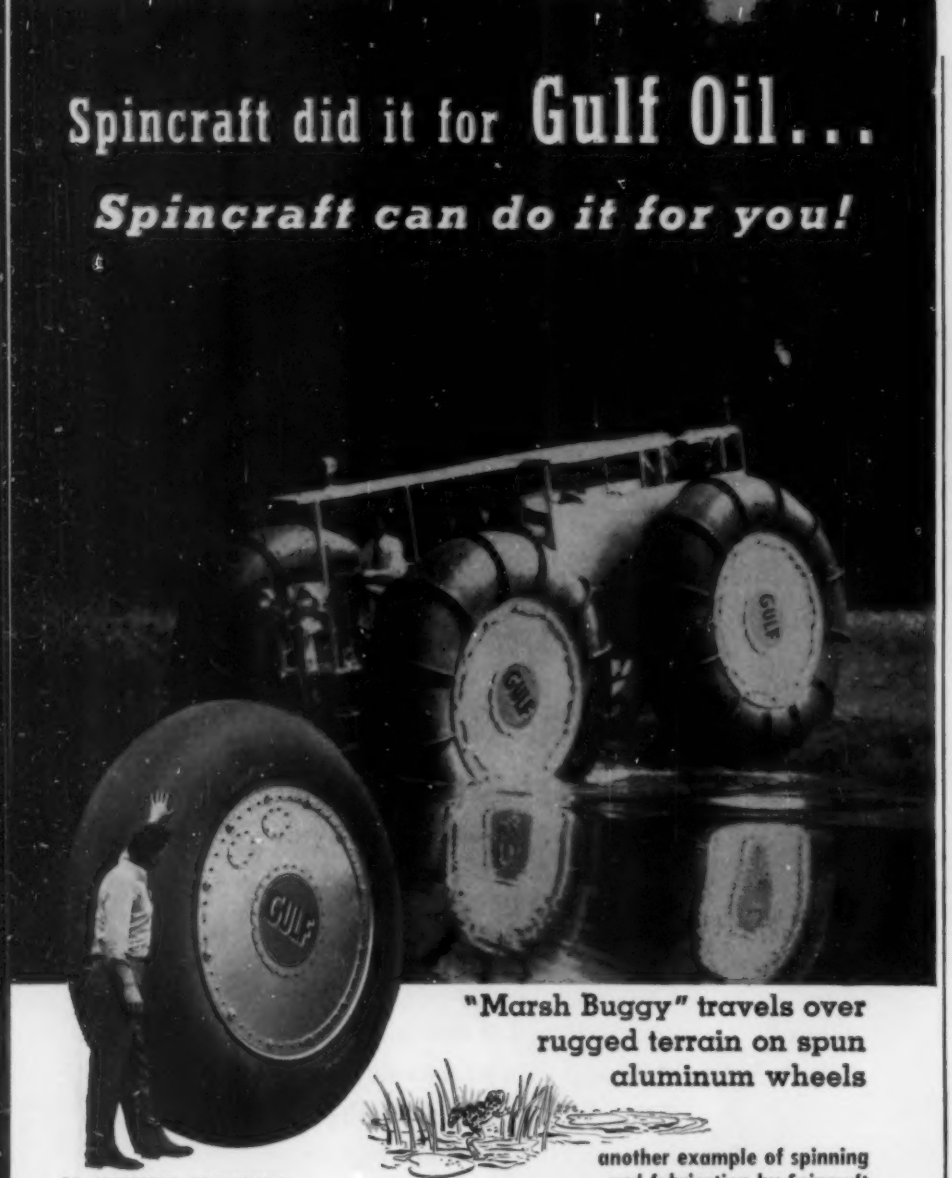
Spincraft can do it for you!



"Marsh Buggy" travels over rugged terrain on spun aluminum wheels

another example of spinning and fabrication by Spincraft

13 DIFFERENT OPERATIONS

The "Marsh Buggy" rolls on sturdy, lightweight aluminum wheels — spun and fabricated by Spincraft. Even if all four balloon tires fail, the spun aluminum air-tight wheel drums will keep the vehicle afloat. Wheel flange segments, extensions, .118" thick 52SO aluminum stiffener ribs, No. 11 U. S. gauge (.125" thick) stainless steel front hub cones were machined and assembled to complete the wheels. In addition to spinning, Spincraft performed the following operations: welding, grinding, polishing, machining, punching, braking, drilling, tapping, sawing, riveting, assembly and testing.

WHEN Gulf Research & Development Co., a division of Gulf Oil Corp., contracted to build their world-famous "Marsh Buggy" for the U. S. Army, Gulf called on Spincraft to fabricate all four wheel assemblies.

These huge wheels are designed to bear loads of 1,500 to 4,000 lbs. Combining strength with lightweight, these tough aluminum alloy wheels can take grueling cross-country punishment. The 10-ft. dia. tires easily negotiate swamp, water, sand, deep mire and other difficult terrain, at speeds from ¼ to 40 miles per hour.

This is another example of Spincraft's versatility and manufacturing skill. Complete facilities are available for all types of contract manufacture — finished parts, assemblies and complete products. Take advantage of our modern tools for spinning and fabricating. They can pay off in savings for you, too.

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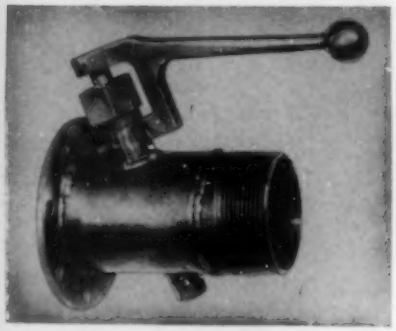
changed. Flow is only slightly affected by pressure, temperature or viscosity. Fluid Controls Inc., 1284 N. Center St., Mentor, Ohio.

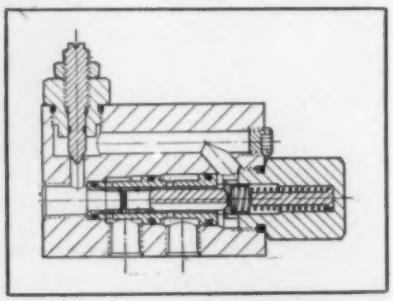
For more information— Circle 96, inside back cover



Ecliptic Valve

A quick-acting valve designed for petroleum tank trucks and similar equipment is of fabricated steel construction with stainless steel stem, brass disc and trim. The seat is of composition material. The new unit weighs 7½ lb in the 3 in. size, the inside diameter of which is increased ¼ in. for better flow. Betts Machine Co., Warren, Pa.

For more information— Circle 97, inside back cover



Drain or Sampling Valve

This valve is completely self-draining, for the valve stem seats on the outside of the valve body. It is suggested for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent liquid from remaining in the nipple and valve. Optional features available include construction with an additional outlet for such uses as a steaming out connection, or with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

The new valve is recommended for

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ELECTRIC MOTORS
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215 Frame

Wagner Totally-Enclosed Fan-Cooled Motors

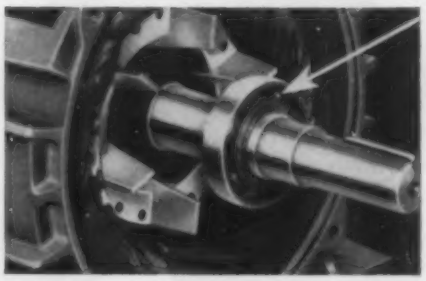
cut maintenance time and costs

Check the features of the new *Wagner Type EP Totally Enclosed Motor*. They spell the difference between needless expenditures in maintenance time and costs . . . and a definite savings in motor upkeep and repairs. You'll find that for general industrial use where dust, dirt, filings, abrasives, steel chips or moisture are present, the Wagner Type EP Motor gives steady, troublefree performance and longer service life.

Wagner Type JP Explosion-Proof Motor . . . has the same quality construction as the Type EP — plus added features which make it completely safe to operate where explosive dust, gases or vapors are present.

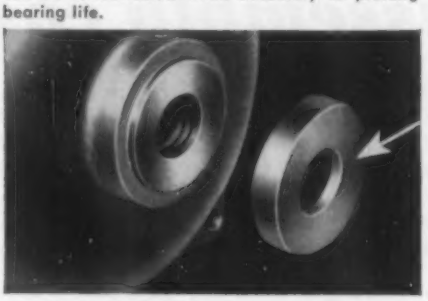
Both Type EP and JP Wagner motors are available in ratings up to 250 horsepower. For complete information, just call the nearest of our 32 branch offices, or write for Bulletin MU-203.

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo.

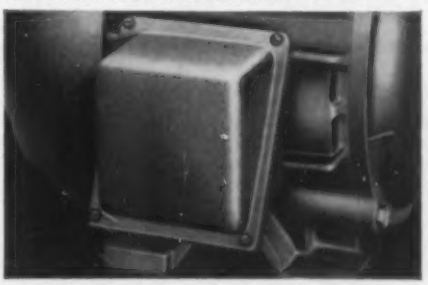


1 HEAVY-DUTY BALL BEARINGS—Highest quality bearings of more than ample capacity provide long, troublefree service.

2 BEARINGS CAN BE RE-LUBRICATED—Wagner motors can be re-lubricated when necessary to prolong bearing life.



3 BEARINGS STAY CLEAN—Both ends of these motors are equipped with running shaft seals, a machined collar mounted on the motor shaft.



4 EASY TO CONNECT—Large diagonally-split conduit box provides ample room for making connections. Leads are permanently identified.

5 NO GREASE LOSS—Bearing housings have effective seals to prevent escape of grease.

6 RIBBED FRAME—Ribs on the corrosion-resistant cast iron frames add mechanical strength and increase the surface area for more efficient cooling.

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Company.....

Address.....

Product being assembled.....

pressures up to 4000 lb at 100 F or 1000 lb at 750 F. Standard with ¾ in. NPT male tank connection and ¾ in. NPT female drain connection. Weight is 4½ lb. Standard materials are carbon steel body, stainless steel stem and Stellite seat. Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

For more information—
Circle 98, inside back cover

Check Valve for 3,000 psi

Check valve has its static o-ring body seal located so that it confines pressure to the strongest part of the body. A cracking pressure of 0.5 to 1.0 psi combined with low pressure drop and leak proof reseating make this new valve suitable for use in vacuum and low pressure gas systems, as well as high pressure pneumatic or hydraulic circuits. Bodies are of brass, aluminum, steel and stainless steel, ranging in size from ⅛ to 2 in. James-Pond-Clark, 2181 E. Foothill Blvd., Pasadena 8, Calif.

For more information—
Circle 99, inside back cover

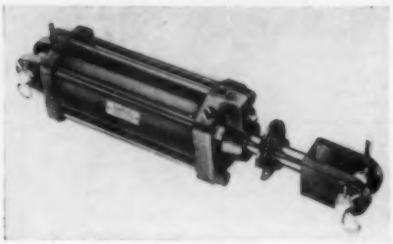
Electrically Operated Power Cylinder

To convert a small electrical signal to a relatively great mechanical force these cylinders use a controlled explosive force to lift, and momentarily hold, various weights through a varied range of distances. With lifting times measured in microseconds, they are adaptable to a wide variety of uses, such as remotely controlled safety and locking devices, opening or closing electrical circuits and ejection of equipment from aircraft or guided missiles.

The power cylinder uses an OM-1B-

700 replacement cartridge to lift and momentarily hold a 100-lb weight through a distance of 2½ in. in an elapsed lifting time of 82,000 microsec. Using an OM-1B-250 cartridge, the power cylinder can lift and momentarily hold a 45 lb weight through a distance of ½ in. in an elapsed lifting time of 42,000 microsec. Atlas Powder Co., Wilmington 99, Del.

For more information—
Circle 100, inside back cover



Depth Control Cylinders

The depth control device on this cylinder allows positive setting of the stroke movement of the cylinder arm, permitting easy selection of any stroke setting required in operation. These cylinders are available from stock in a 3½ in. bore, 8 in. stroke. Recommended working pressure is 1500 psi. The cylinder has ½ in. ports, and is available with clevis mounting. Dukes Co., Inc., 3999 N. 25 Ave., Schiller Park, Ill.

For more information—
Circle 101, inside back cover

Rotating Hydraulic Cylinder

This rotating hydraulic cylinder is said to provide greater force in a smaller area than is possible with an air cylinder. Built in various bore sizes, it is rated for use with pressures up to 750 psi and at speeds up to 3000 rpm. The cylinder is alloy iron and is balanced for high speed use. S-P Mfg. Corp., 12415 Euclid Ave., Cleveland 6, Ohio.

For more information—
Circle 102, inside back cover

Removes Waste From Air Tanks

This automatic ejector will remove water, oil, carbon and sludge from air tanks used in factories, repair depots,

NOW A ¼" DIAMETER SEAMLESS METAL BELLOWS

Bridgeport Thermostat's broad experience in bellows engineering now makes available ¼" and 5/16" diameter bellows. Ideally suited to miniaturization, these tiny units are produced in a wide range of characteristics and metals. Bridgeport specializes in metal bellows and complete bellows assemblies of all types and sizes. Send for new bellows engineering data—use handy coupon below.

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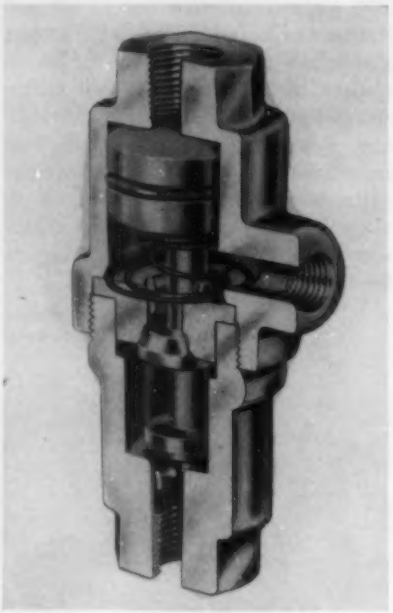
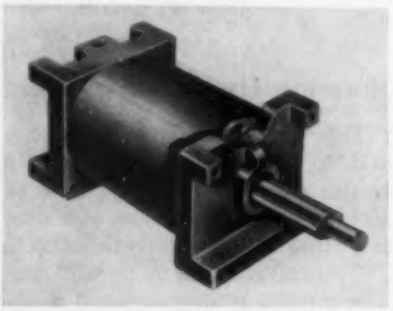


portable air compressors and diesel locomotives. With two moving parts, the device needs no supports or adjustments and uses no screens, diaphragms, washers or gaskets.

Made of die-cast aluminum with molded nylon seats, the ejector weighs 10 oz and operates on pressure taken from the governor or unloaded line. Unloader pressure opens the valve and reservoir pressure closes the valve. George Mfg. Co., 10-16 Harvey St., Philadelphia 44, Pa.

For more information— Circle 103, inside back cover



Pneumatic-Hydraulic Cylinder With Elliptical Piston Rod

A cylinder with a hardened and ground elliptical piston rod that assertedly cannot rotate is said to eliminate the need for external guide bars or ways and reduces fixture set-up time. Designed with a spring return, this single-action push-type cylinder is used for clamping, ejecting, stamp-

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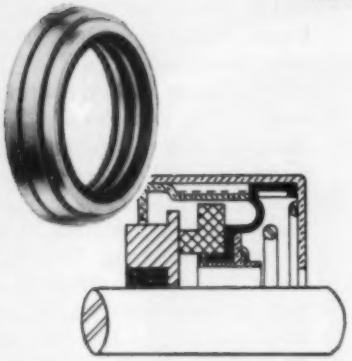
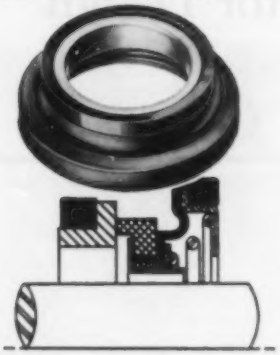
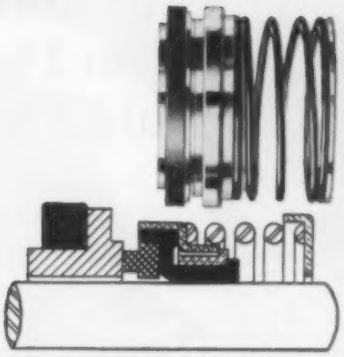


STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in **machine tools** and **power transmission equipment.** Stock sizes for shafts .250 through 4.000.

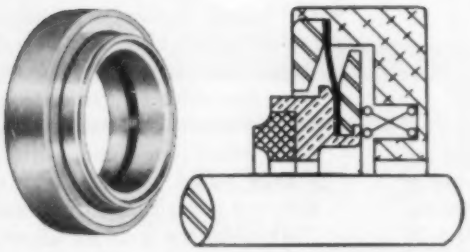


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in **appliance** field. Stock sizes for shafts .250 through 1.000.

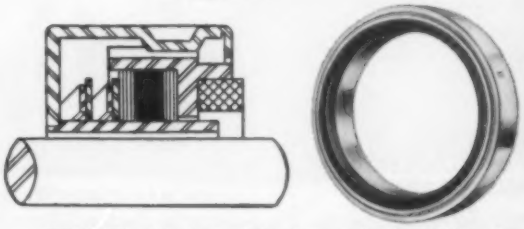


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in **pumps** and **compressors.** Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many **machine tool** applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the **aircraft** industry. Stock sizes for shafts .250 through 4.000.

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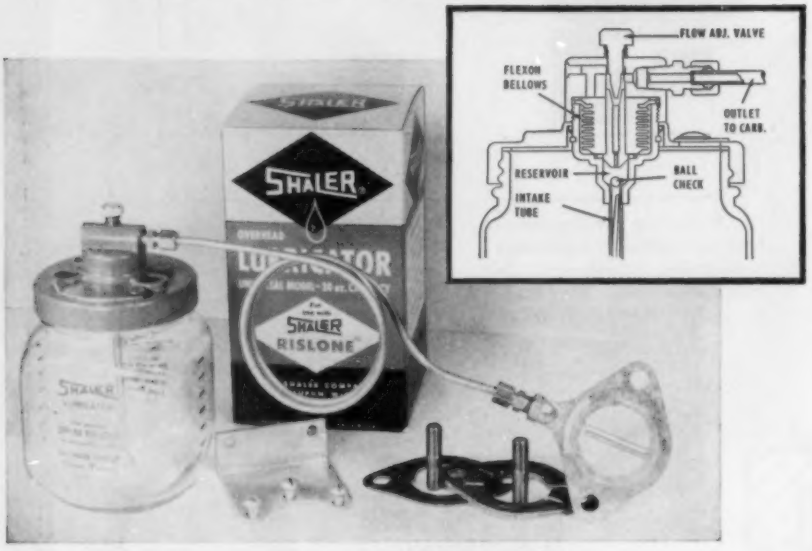
FLEXON BELLOWS *Design Briefs*

Overhead Lubricator Design Depends on Flexon Bellows For Fluid Flow Control



FLEXON OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel for vacuum equipment, thermostatic devices, pressure controls, packless valves, pneumatic instruments, hydraulic mechanisms, rotating shaft seals and many other services.

The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy.

● The Shaler Lubricator, manufactured by The Shaler Company, Waupun, Wisconsin is a device for feeding lubricant through the intake ports of internal combustion engines. It is designed to provide maximum lubrication when the engine is under load at low vacuum.

To make the unit sensitive to variations in intake manifold pressure, a ⅜" I.D. Flexon brass bellows assembly is employed in the operating mechanism. The bellows is subjected to a maximum vacuum of 25" of Hg. with a normal operating vacuum of 8" to 11". Vacuum is pulsating with variable frequency. It must withstand a temperature range from —35° to 200° F.

The Shaler Company has standardized on Flexon Bellows because they provide the dependable performance that keeps customers sold. You can put this kind of dependability to work for you if you specify "Flexon Bellows." For specific recommendations, send an outline of your requirements.

Flexonics *Corporation* — FLEXON BELLOWS DIVISION

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

—FORMERLY CHICAGO METAL HOSE CORPORATION—

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components. In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

ing, staking, locating and various other jobs. It is said to meet any mounting requirement and can easily be attached or removed. Both heads permit either flush or foot mounting to a horizontal or vertical plane.

The new cylinder is cast of Meehanite. Inside walls are bored and roller burnished to 6 micro-inch finish. All wear parts are non-corrosive. Cylinder walls and pistons are hard-chrome plated, and guide bushings are made of oil-impregnated porous bronze. Available in six different sizes, the cylinders range from 5 to 8 in. in length and from 3 to 5⅜ in. in width and height. All sizes are also available mounted on ¼, ½ and ¾ ton arbor press (at 100 lb pressure). Alkon Products Corp., 200 Central Ave., Hawthorne, N. J.

For more information— Circle 104, inside back cover

Square-End Air Cylinders

These air cylinders are available in 11 bore sizes from 1½ through 14 in. and with 21 types of mountings. They are designed to JIC standards and feature brass tubes to eliminate corrosion, removable bronze cartridge containing wiper and rod packing, and cold rolled steel end plates. The chrome-plated rod has four wrench flats and is available in optional sizes. Pistons and tie rods are secured with lock nuts. On cushioned models, cushions float on an O-ring for accurate self-alignment. These cylinders can be supplied with either single or double rod ends. S-P Mfg. Corp., 12415 Euclid Ave., Cleveland 6, Ohio.

For more information— Circle 105, inside back cover

Gas Charging Valve

This valve is interchangeable with any previous AN valve being used to charge hydraulic and pneumatic system with gas. Designed for a 5000 psi working pressure and 20,000 psi burst pressure, the valves are being used in landing gear, accumulators and similar applications.

A prime safety factor of the valve is the pin built into the locking head which prevents the stem from dropping into the body of the gas cylinder eliminating the resultant equipment damage. An adjustable stem that works as an ice crusher eliminates ice forma-

THE ALL NEW

CAST-IRON TOTALLY-ENCLOSED MOTOR

TYPE J

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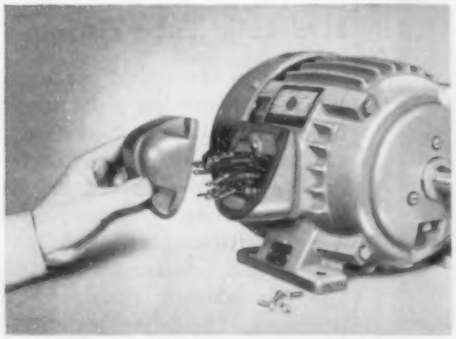
The new dimension standards recently adopted by NEMA offered timely opportunity to introduce the new Types J and E, providing more compact power, greatest safety and better value.

with

SPLIT DOME CAST-IRON CONDUIT BOX



The conduit box is a heavy duty, cast-iron, diagonally split type, neatly contoured and easiest of access. It is fitted with a special gasket and is anchored to the case with four screws. Leads are positioned, lugged and clearly marked. The box can be rotated to any of four positions.

U. S. TOTALLY-ENCLOSED

The frame, end bells, fan guard cover and conduit box of the new Type J (Totally-Enclosed) and Type E (Explosion-Proof) U. S. motors are all made of cast iron to offer complete protection against corrosive conditions and external blows. The shock-resistant, cast-iron frame is heavily ribbed for added strength and rapid heat dissipation. The iron grille is cast integrally with the fan guard. It permits maximum flow of air to the ventilating fan, prevents entrance of debris and avoids breakage. These, plus many other exclusive U. S. features such as asbestos-protected windings, Lubriflush transverse lubrication, and normalized castings, make U. S. Totally-Enclosed motors the most advanced concept of complete protection for dangerous duties.

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tion around the gas inlet ports caused by the accelerated and expanding charging gas. The stem permits the complete and safe charging. Superior Hydraulics Div., 15201 St. Clair Ave., Cleveland 10, Ohio.

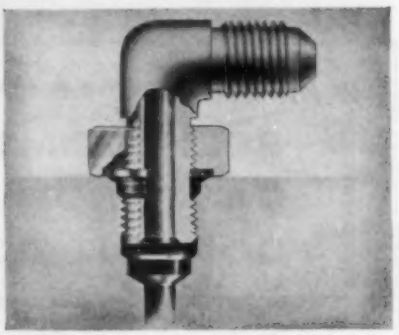
For more information— Circle 106, inside back cover

Fitting For Instrumentation Tubing

A tube is inserted through this fitting's nut and ferrule until it bottoms on the seat within the fitting body, and then the nut is tightened. The wedging action of the nut causes the ferrule to "bite" into the outer surface of the tube wall, turning up a "shoulder" of metal to provide a leakproof, vibration-proof connection.

The new fitting is available in all commonly used body shapes and for tubing of ¼ through 1 in. OD. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information— Circle 107, inside back cover



Hydraulic Tube Fittings

Using an O-ring and boss combination to obtain a leak-proof seal, these fittings can be directionalized with ease in any material and require approximately the same installation space as previous designs. No special tools are required to install the new fittings, and defective or worn threads have no influence on the efficiency of sealing. The fittings incorporate an appropriately shaped body in either straight or angular form, having a standard JIC 37 deg flare end for connection to the tubing. Upper and lower straight threads are located on the end of the fitting opposite the flair, with a hex nut turning on the upper threads.

Fittings having straight, 45 deg

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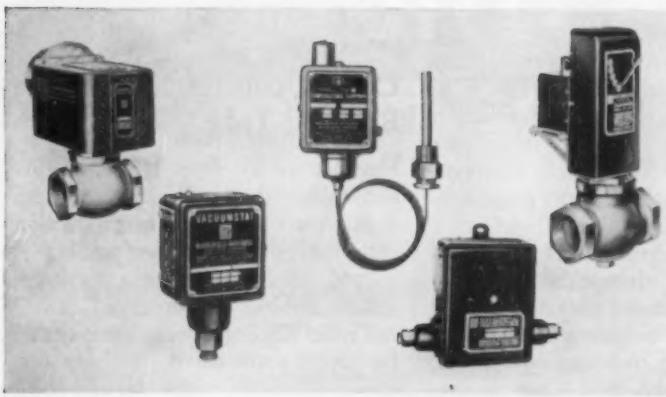

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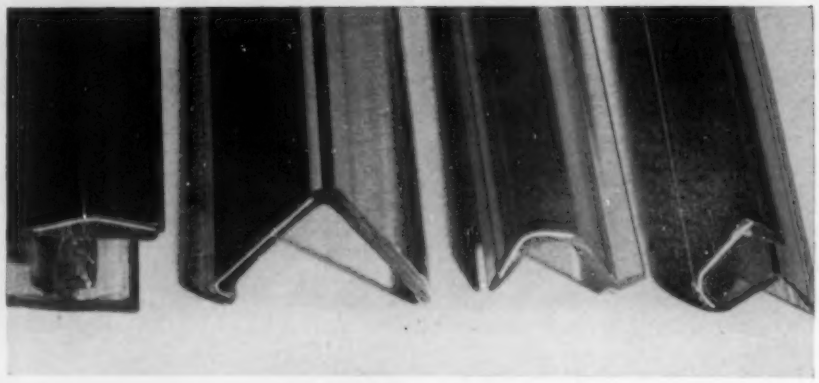
elbow, 90 deg elbow, male outlet tee and male run tee bodies are available in sizes to fit $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, and 1 in. tubing, as well as plugs and female adapters designed to fit the bosses employed with each of these sizes of tube fittings. Monarch Machine Tool Co., Sidney, Ohio.

For more information— Circle 108, inside back cover

ENGINEERING MATERIALS



Plastic Extrusions with Embedded Metal Foil

These extrusions are useful as trim-strips and functional molding for cabinets, joining strips, printed decorative designation strips or wherever visual appeal is important. They combine the brightness and depth of polished metal with the practicality of plastic extrusions.

The effect is achieved by permanently embedding bright metal foil into thermoplastic extrusions, providing a metallic finish protected from wear, scratch, rust and corrosion and not affected by perspiration or fingerprints. The manufacturer can extrude shapes to manufacturers' specifications in U, H, L, T, V, E and other cross-sections. They can be bent, drilled or mitered, as well as printed, silk screened, hot stamped or otherwise decorated. Anchor Plastics Co., 36-36 36 St., Long Island City, N. Y.

For more information— Circle 109, inside back cover

Isothane Foaming System

This two-component polyurethane system is applied by spraying or pouring. It can be used for coating surfaces and filling voids where the use of foamed plastics previously was not practical. Isocyanate resin can be expanded to variable density of 3 to 15 lb per cu ft. It has good adhesion to all types of surfaces; its impact and vibration resistance is excellent. It has excellent dielectric properties, chemical resistance, thermal insulation and acoustical qualities. It has practically no water absorption properties.

The basic foaming resin and catalyst are pre-mixed in proper proportions through special metering equipment. The mixture leaves the blending nozzle and expands within the area into the foamed resin. Surface Chemicals, Inc., 1101 Thompson Ave., McKees Rocks, Pa.

For more information— Circle 110, inside back cover

Large Diameter Fluorothene Rod and Tube

Fluorothene rod from $\frac{3}{8}$ to 5 in. OD and tubing in wall thicknesses from $\frac{3}{8}$ in. is available now in production quantities. The rod and tubing is x-rayed to detect cracks, internal strains, bubbles or porosity.

These Kel-F products are suitable for severe applications involving corrosive chemicals, solvents and heat

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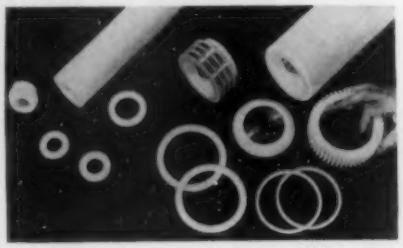


from −300 F to 400 F in continuous service. Chemically-inert and non-adhesive, with little friction, the material is suitable for applications in chemical laboratories and electronics. Uses include laboratory wear, insulation, gaskets and handling of corrosive fluids. Shamban Engineering Co., 11617 W. Jefferson Blvd., Culver City, Calif.

For more information—
Circle 111, inside back cover

Cross-Linked Vinyl Coatings

This vinyl coating is specifically formulated for roller coating operations. Furnished at 40 to 42 per cent solids and a viscosity of 85 to 95 sec (No. 4 Ford cup), the specified baking cycle is from 350 to 400 F.

Available in colors as well as white, this coating is suggested for caps, closures, trays, canisters, strip coating and other similar applications where fabrication and chemical resistance are basic requirements. Watson-Standard Company, 237 Galveston Ave., Pittsburgh 12, Pa.

For more information—
Circle 112, inside back cover

Centrifugally Cast Nylon Tubes

Accurately turned and concentrically bored nylon tubular bars are available for the fabricating of large diameter bearings, thrust washers, wheels, gears and seals. These bars are said to be the first large diameter, heavy walled nylon tubing available in precision sizes. Stock costs are less per foot than for solid pieces, and drilling operations are eliminated entirely.

The size range is similar to that generally available in brass and bronze. This permits use of familiar machining techniques on standard metal working equipment.

After being cast to approximate size, the tubular bars are annealed and

machined to close dimensional tolerances. Outside diameters range from 2 through 10 in. with wall thicknesses of $\frac{3}{8}$ through 1 in. Standard lengths are 8 and 13 in., although as originally cast they run 24 and 26 in. long. Polymer Corp. of Pennsylvania, Reading, Pa.

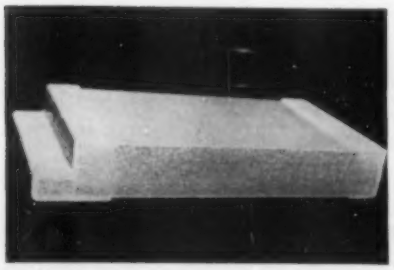
For more information—
Circle 113, inside back cover

Asbestos Sheet Packing

An asbestos sheet packing has been announced for use as gasketing in industrial plants, mines, railroads, ships and institutions. Designated as No. 90 sheet packing with a gray-black color, it is suitable for handling steam, hot and cold water, brine, air and oil up to 300 psi and 500 F. Average tensile strength of cross-laminated material is 4500 psi and for homogenous packing 3000 psi. It analyzes 70 per cent ash with a 2 per cent water absorption.

This packing is made in three thicknesses, $\frac{1}{32}$, $\frac{1}{16}$ and $\frac{1}{8}$ in. and in three sheet sizes, 48 x 48 in., 48 x 72 in., and 48 x 144 in. The material weighs 2.6 lb per sq yd in the $\frac{1}{32}$ in. thickness. Thermoid Co., Trenton, N. J.

For more information—
Circle 114, inside back cover



Plastic Sandwich Panel

An insulated plastic sandwich construction panel is composed of an expanded polystyrene core with a facing of glass fiber cloth reinforced polyester sheet. The panel is said to

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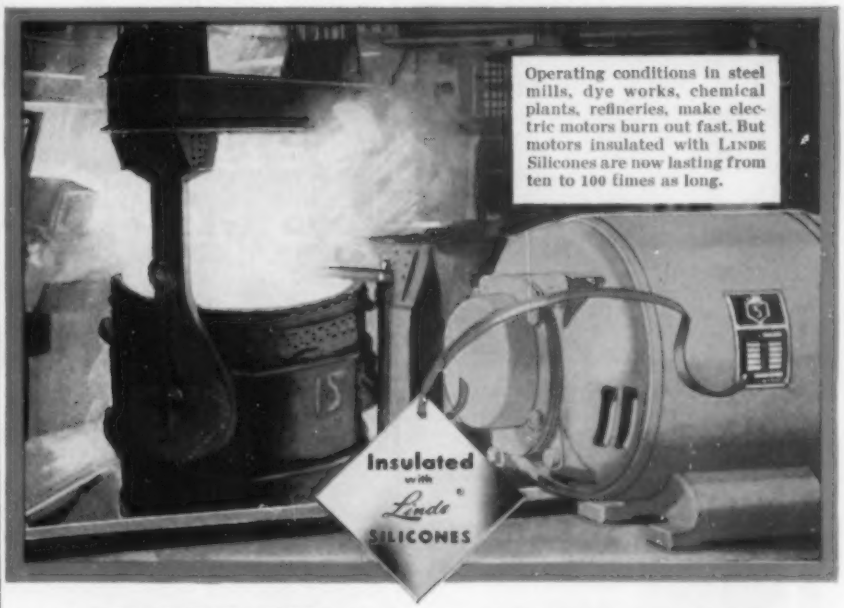
Linde TRADE-MARK **silicones**
toughen up electric motors


Operating conditions in steel mills, dye works, chemical plants, refineries, make electric motors burn out fast. But motors insulated with LINDE Silicones are now lasting from ten to 100 times as long.
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LOOK AT the reasons why

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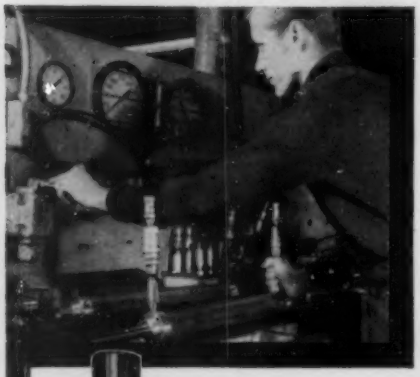

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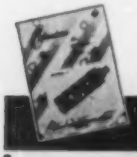

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be moisture-proof and corrosion-resistant.

The core has a density of 2 lb per cu ft or higher and is covered with the reinforced glass fiber cloth in 0.018 and 0.032 in. thicknesses. The standard sandwiches are 1, 2, 3, 4 or 6 in. in thickness. Special sizes run as high as 18 in. Standard width is 48 in., with lengths 96, 120 or 144 in. Haskelite Mfg. Corp., Grand Rapids, Mich.

For more information— Circle 115, inside back cover

Plastic Foam Materials

A series of plastic foam materials which combine high dielectric constant and low weight have a low dissipation factor and are useable from −65 F to 275 F. They are presently available as sheet stock, which can be machined readily, or as custom molded shapes of exact dimension. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

For more information— Circle 116, inside back cover

ENGINEERING EQUIPMENT

Slide Rule Spring Computer

This spring computer correlates, in one setting, all the variables in spring design, outside diameter of spring, wire size in diameter and gage number, number of active coils, material and its torsional modulus G, maximum sheer stress, load and total deflection. All figures are directly read off without any intermediate computation, as no reference is made to a standard load, or a standard G, or a standard number of coils. The stress scale includes the correction for non-linear distribution of torsional stresses in curved wires.

The computer is 11 in. long and is produced from sheets of tough, non-warping dimensionally stable plastic. All scales appear on one side of the computer. American Hydromath Corp., 25-20 43 Ave., Long Island City 1, N. Y.

For more information— Circle 117, inside back cover

Transfers Provide Section Patterning on Tracings

A wide variety of patterns useful for indicating sections of engineering drawings involving specific materials or having certain characteristics requiring visual indication in tracings and blueprints are now available in the form of transfers. To apply, a part of an 8 x 12 in. sheet is stripped of its carrier sheet and placed over section requiring pattern. After light rubbing, material is trimmed to fit. Bone burnisher is used to complete adherence, which is said to resist roughest handling and temperatures normally encountered in blueprinting equipment. Para-Tone, Inc., 512 W. Burlington Ave., La Grange, Ill.

For more information— Circle 118, inside back cover

Pocket Slide Rule

The scales provided on this 5-in. rule are K, A, B, C1, C, D, S, and T. The beveled leading edge incorporates both inches and millimeters. Weight is less than 1 oz and thickness $\frac{5}{32}$ in. Alvin & Co., Windsor, Conn.

For more information— Circle 119, inside back cover

Transient Force Recorder

This recorder measures, on 35 mm film, the magnitude and duration of transient forces. Weighing less than 10 lb in a case measuring 4 x 6 in., the new recorder is available in ranges of 4000, 7500 and 15,000 lbs for recording forces with a natural frequency of 1000 cps. A flashing neon lamp, controlled by a subminiature oscillator, exposes time lines on the film at a rate of 25 per sec. The film length is 18 in. and film speed can be set at any value from 0.7 to 2 in. per sec.

The recorder was developed for the U. S. Air Force to record the time and

When No Other Material Can Meet Your Electrical Requirements

New tube cap connector made of KEL-F Plastic insures high insulation resistance, and excellent dimensional stability over a wide temperature range (—320° to 390°F.) for critical installations.

KEL-F® PLASTIC *IS* UNIQUE. A polymer of trifluorochloroethylene, its molecular construction produces a combination of outstanding properties headed by excellent electrical characteristics, resistance to chemical attack and negligible deformation under load.

KEL-F Plastic is dense, tough, and readily moldable. It has an operational temperature range of approximately 710° F. (—320° F. to 390° F.) KEL-F Plastic is non-wettable, and moisture absorption is zero! In electrical applications it can be used structurally as well as dielectrically—particularly in the critical electronic applications encountered in sub-miniaturization, automation, servo-mechanisms, etc. And, as wire insulation, KEL-F Plastic offers outstanding abrasion resistance, so important in aircraft and other critical installations.

KEL-F Plastic is available as a molding compound, or in extruded film, sheeting, rods and tubing from independent fabricators. KEL-F Dispersions for bake-coating of metallic surfaces are also obtainable. The complete story of KEL-F Plastic should be in your "ready" file. Write for special bulletins.

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Chemical Manufacturing Division, P. O. Box 469, Jersey City, N. J.
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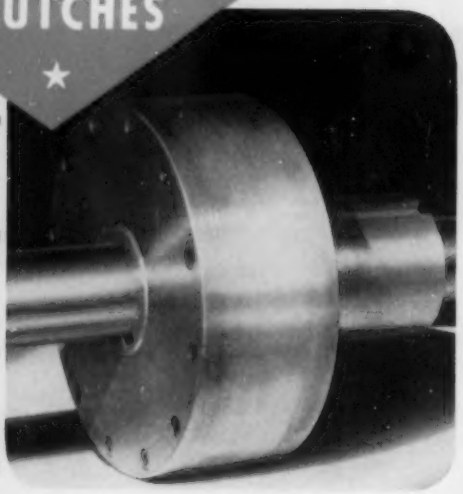
3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.



50 YEARS of satisfactory service proves you can depend on Hilliard Over-Running Clutches and Couplings for long service on—

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- TWO SPEED DRIVES for dry cleaning machines, laundry equipment, conveyors, paper processing machines, slitters, forming rolls and automatic machinery.
- RATCHET ACTION for printing press ink rolls, coal feeders, press feeds, honing machines, bakery equipment and conveyors.
- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

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THE HILLIARD CORPORATION
MANUFACTURING CLUTCHES FOR OVER 50 YEARS
101 West Fourth St., Elmira, N. Y.

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transient forces exerted by a parachute on its load during deployment and deceleration. Modified for widespread industrial use, the new recorder is powered by four standard "B" and two standard "A" batteries. A spring-powered motor drives the camera at a constant speed during the recording period. A mechanical governor, not affected by acceleration, controls the speed of the motor and permits adjustment of the recording time between 9 and 25 sec. Exline Engineering Co., 1636 E. 6 St., Tulsa, Okla.

**For more information—
Circle 120, inside back cover**

Whiteprinter Operates At Up to 70 fpm

This fast printing speed is obtained by the use of a new inexpensive 5000 w printing lamp. Development is accomplished through the unique design of the multiple interlocking roller developer, which permits the use of full strength 26 deg aqueous ammonia. Manufactured in 42 and 54 in. sizes, the unit should be useful in any blueprinting or reproduction department. C. F. Pease Co., 3816 N. Rockwell Ave., Chicago 18, Ill.

**For more information—
Circle 121, inside back cover**

Measurement of High Resistance Values

This ohmmeter posseses a unique zero adjustment which compensates for varying battery voltages. Once set for one scale, the adjustment is accurate for all scales on the meters, eliminating the necessity for readjusting to zero for each change of scale range.

Automate for top performance with . . .

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Peru 4, Illinois Mills: Peru, Ill. — Walnutport, Pa.

The meter can be supplied with mercury cells which retain constant voltage, and under such circumstances the zero adjustment usually remains for several weeks. Greibach Instruments Corp., Metuchen, N. J.

For more information—
Circle 122, inside back cover

Printed Circuit Design Kit

An assortment of copper-clad phenolic laminates is provided in this kit, including double-surfaced as well as single-surfaced boards. Tube sockets of ten different types allow design engineers to experiment with numerous variations of model design. For applications where interchangeable circuitry is important, the special multicontact printed circuit connectors should be useful. Techniques, Inc., 135 Belmont St., Englewood, N. J.

For more information—
Circle 123, inside back cover

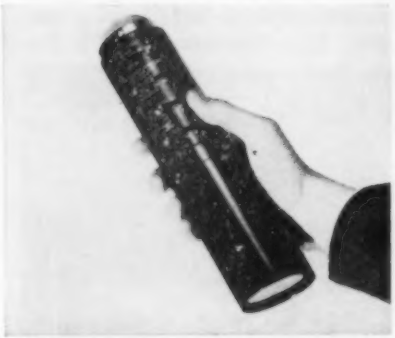
Portable Electronic Counter

This counter can measure frequency, speed, rpm, random events, weight, temperature, pressure, acceleration and other phenomena. It weighs 25 lb and is housed in an aluminum

cabinet. The period of count is either $\frac{1}{10}$ or 1 sec, and the count display time can be varied at will. The instrument uses conventional power line frequency for counting time base; or is available with a plug-in crystaltime base for measurements of more precise accuracy.

Model 521A includes three accessory power supplies of −150 v, dc, 300 v, dc, and a 6.3 v, ac, filament supply. Connections are also supplied for photocells and an external standard. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.

For more information—
Circle 124, inside back cover



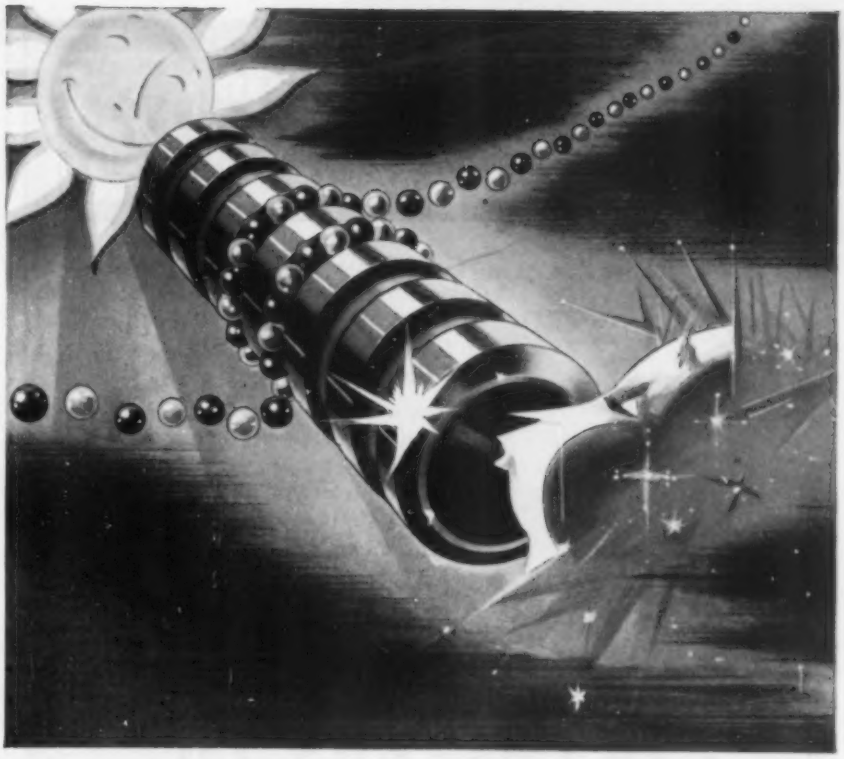
Sound Level Meter

The 410-C is used for accurately measuring noise, sound and vibration from equipment such as blowers, ventilating fans, aircraft noise analyses, industrial hygiene studies and acoustical surveys. Portability is made possible by the use of subminiature tubes and components, and patented miniaturization techniques. The meter meets all specifications of the ASA for sound level meters. The sound level range is from 34-140 db above the standard ASA reference level of 0.0002 dynes per square centimeter. The meter uses readily obtained hearing-aid batteries with an operating life of about 50 hr. Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.

For more information—
Circle 125, inside back cover

Bridge Amplifier and Meter

For both static and dynamic work with SR-4 strain gages and similar types of resistance transducers, this unit is self-contained. It reads directly on its own 4 in. meter. A calibration system permits setting the scale up



THIS SCREW ROLLING ON BALLS
operates in
high- and low-temperature areas

Over a wide temperature range, AEROL Ball-Screws which move entirely on steel balls eliminate the need for lubrication. They operate in high-temperature areas without danger of fire and thinned-out grease and in low-temperature areas without the problems of stiffened grease and sluggish operation. They also assure fast, precise, continuous positioning down to near-*zero* tolerance.

Replace the common high-sliding-friction screw with an AEROL Ball-Screw mechanism, and you can almost double drive efficiency, allowing you to save on motor size and weight, cost, space and electricity required.

These AEROL Ball-Screws are at work now on aircraft, on trucks and cars, on machine tools, on standard and special equipment of all kinds.

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BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

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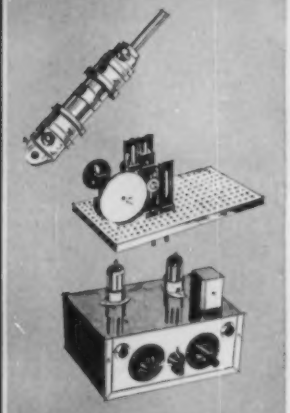

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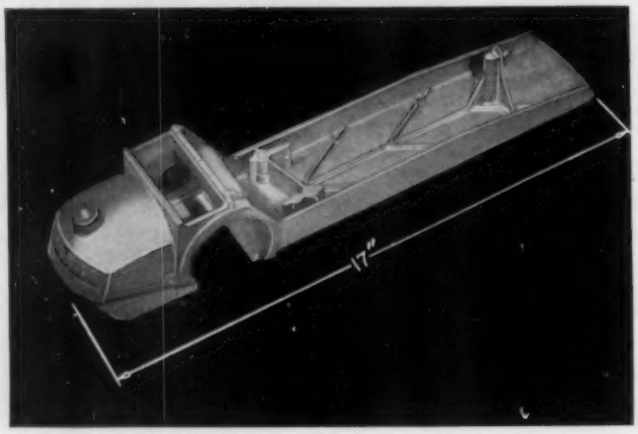

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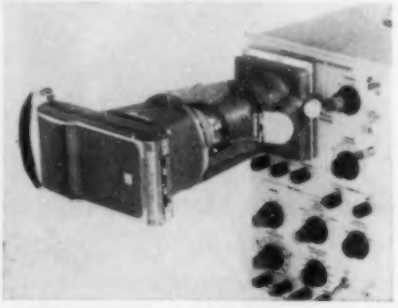
directly in terms of units to be measured-pressure, load, displacement, acceleration.

For dynamic work a d-c cathode-ray oscilloscope is plugged in and a complete d-c signal with flat frequency response from dc to 20,000 cps is provided. Ellis Associates, Box 77, Pelham, N. Y.

For more information—
Circle 126, inside back cover



Oscilloscope Camera

This camera is based on an adaptation of the fast-print magazine, providing a picture in 60 sec. It mounts easily on any standard 3 or 5-in. scope. Swing-away camera hood and mounting plate are included in a packaged accessory group. Three exposures can be made on a single $2\frac{1}{8}$ x $2\frac{7}{8}$ in. blackfield print, through the scope centering control adjustment. Aremac Associates at 50 S. San Gabriel Blvd., Pasadena, Calif.

For more information—
Circle 127, inside back cover

High Voltage Power Supply

The stability of this power supply is said to be limited only by the voltage reference tubes, which are the new 85A2 types operated under constant current. The voltage variation of these tubes is less than 10 ppm per hour for their first 1000 hr, and less than 2 ppm thereafter. When switched by

coarse control, voltage may be reset to better than 10 ppm at any time.

The N-401 provides continuously variable voltage from 500 to 1800 v positive, at load currents up to 5 ma. Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J.

For more information—
Circle 128, inside back cover

Three-Phase Power Supply

This unit supplies 500 va of 300 to 500 cps power into a delta-connected load. The output voltage is variable from 103 to 126 v with regulation of better than 1 percent no-load to full load. Fifteen decibels of negative feedback insures low dynamic output impedance and keeps the maximum distortion less than 7 per cent under full load conditions. Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena, Calif.

For more information—
Circle 129, inside back cover

Regulated Power Supply

The Model 702A provides output voltages of 0 to 600 v, continuously variable, with currents up to 200 ma. Regulation is maintained at ¼ per cent or better, with ripple less than 10 mv,

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Gentlemen: Please send me a copy of Catalog 155 on the new Series "C" Speed Reducers.

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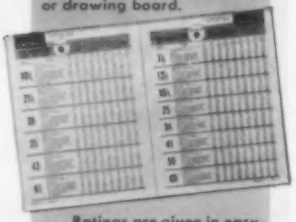
FACTS AT YOUR FINGERTIPS!

Dimension drawings, parts list, shaft arrangements and table of weights are on facing pages for convenience in working. Opens flat on desk or drawing board.



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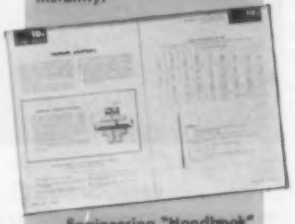

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Between the covers of this new catalog, every design engineer and speed reducer user will find the answer to how they can select speed reducers of more compact dimensions to achieve required output.

With this newly designed "C" Series, Winsmith has succeeded in increasing horsepower and torque output, and increasing the ruggedness of the units *without increasing overall size.* In all, 108 models in single and double reduction are available within the range of .01 to 34 hp; in a ratio range of 5:1 to 4460:1 and in an output torque range of 142 in. lbs. to 34,767 in. lbs. The complete "C" Series plus a number of other popular models in the Winsmith line are catalogued for your working convenience.

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Perkins custom-made Gears *make any device—big or small, simple or complex—*

more efficient, more serviceable, more saleable...

because every human and mechanical advantage in Gear Making goes into their production—and all under management who have spent their lifetime in the Gear Business.

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PERKINS MACHINE & GEAR CO.
105 Circuit Ave., WEST SPRINGFIELD, MASSACHUSETTS

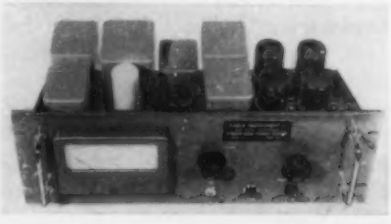
peak to peak. A variable negative output of 0 to 150 v is also provided for bias, as well as 6.3 v at 8 amp. Positive and negative terminals are insulated from the chassis, permitting high voltage to be used above or below ground. Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.

For more information—
Circle 130, inside back cover

High Temperature Accelerometers

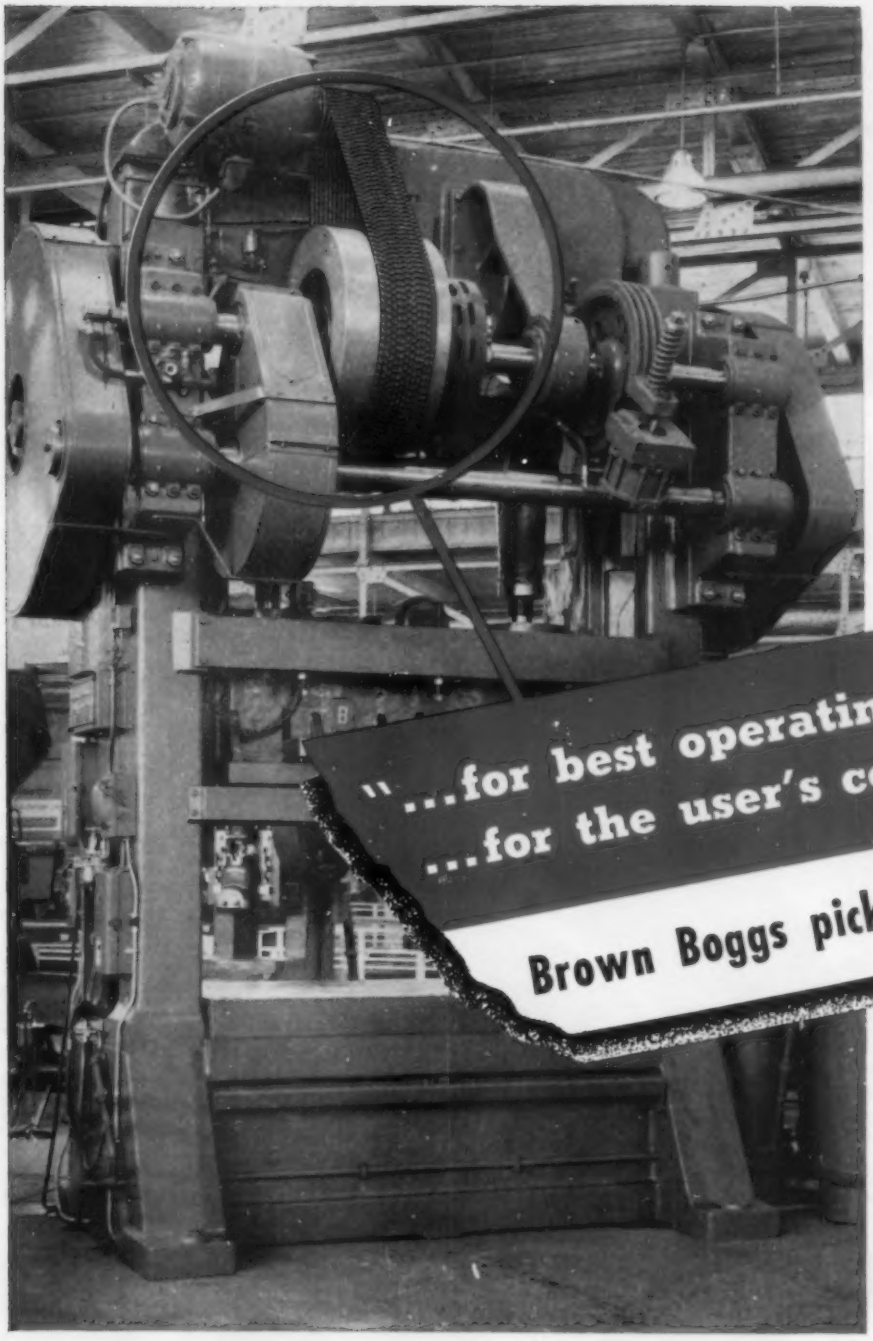
The Model 2205 provides a dynamic acceleration range from 0 to 1000 G, and allows high temperature operation up to 2200 F. The unit weighs 5 oz and is constructed of stainless steel. Endevco Corp., 180 E. California St., Pasadena 1, Calif.

For more information—
Circle 131, inside back cover



Strain Gage Power Supply

This new power supply unit is useful in most strain gage systems as a direct replacement of a battery. Drop-off of output voltage is eliminated, as well as battery charging and maintenance. Complete isolation from the input line results in less than 1 mv ripple from either output side to



The Brown Boggs Foundry & Machine Company, Ltd., of Hamilton, Canada, who manufactures this 200-ton Press, thoroughly checked all types of v-belt. They wanted a v-belt that would give efficient, vibrationless, full power delivery. They wanted a v-belt that could be installed quickly and easily. Only Veelos met *both* requirements. And here's what Brown Boggs says about their selection of Veelos . . .

"...for best operating condition ...for the user's convenience"*

Brown Boggs picked Veelos v-belt

*"*We feel that our own factory assembly has put this Press in the best operating condition. To eliminate the necessity for dismantling any part of the equipment, and for the user's convenience in changing belts, we have equipped the drive with Veelos V-Belting.*"

Brown Boggs selected Veelos even though it cost more than ordinary v-belt. They know, however, that "what's best for their customer, is best for their business!" It will pay you to equip your machines with Veelos v-belt. Once you've done that you'll be an enthusiastic Veelos user, too.

Veelos is known as Veelink in Canada and foreign countries.

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America's only complete optical source . . . from glass to finished product

ground. Output of the new power supply is 5 to 15 v in two ranges at 0-1 amp, continuously adjustable within 0.1 per cent. Ripple is less than 0.05 per cent. Regulation, ±0.1 per cent. Input is 105-125 v, 60 cps. Eagle Instruments, Inc., 14757 Keswick St., Van Nuys, Calif.

For more information—Circle 132, inside back cover

Hardness Tester With Push-Button Control

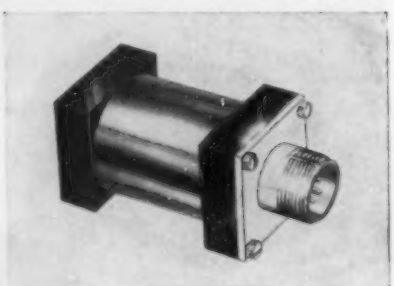
This device contains weights from 100 to 150 kg, which are applied in the case of hardness tests according to Rockwell "B" and "C" scales or as well as the Brinell loading stages. The apparatus can also be supplied with Vickers type testing equipment. Karl Frank GMBH, Weinheim-Birkeman-17A, Germany.

For more information—Circle 133, inside back cover

Regulated D-c Power Supply

Voltage regulation in this power supply is made automatic through magnetic amplifier control. Static regulation is ± 1 per cent from no-load to full load; ripple voltage limitation is 1 v, peak to peak. These units are available in from 4 to 300 v capacities, at all current values from 1 amp. Bart-Messing Corp., 229 Main St., Belleville, N. J.

For more information—Circle 134, inside back cover



Measures Accelerations From 1/10 to 50 G

These accelerometers offer a wide selection of single and multi-axis devices that have been fully qualified for yaw damping, acceleration limiting, turning rate, and similar aircraft appli-

ONLY NOELTING Faultless TRIPLE GREASE SEALED CASTERS

Have NEOPRENE VULCANIZED RETAINERS

(PATENT PENDING)

1 LEAK-PROOF NEOPRENE RETAINER MOLDED AND VULCANIZED ON UPPER BEARING SWIVEL RACEWAY. PATENT PENDING. (not just a metal ring)

2 THRUST BEARING GREASE RETAINER TIGHTLY FITTED AROUND FORMED, HARDENED RACEWAY. CAN BE EASILY REMOVED FOR CLEANING OR INSPECTION.

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1 Molded Neoprene grease seal is vulcanized to upper bearing raceway and snugly fits corrugated ring in top plate. Keeps lubricant in—keeps dirt and water out of swivel bearing. Top surface snaps back to snug fit after old grease is flushed out. Functions normally with standard grease in temperatures as low as 0°F. and as high as 200°F.

Permanent film of grease positively reduces friction and accelerates swiveling.

2 Thrust bearing grease retaining cup provides no-leakage protection and keeps lower ball race free of dirt and moisture. Keeps swivel head lubricated indefinitely. Easily removed, as required.

3 Wheel bearing Neoprene seal is permanently attached to washer and press-fitted into hub. Keeps foreign matter out of roller bearings and ball bearings in hub. Locks in lubricant and assures free rolling of wheels.

4 Double ball bearing construction . . . two full rows of hardened, ground, and polished large diameter balls operate in smooth, lubricated raceways for effortless swiveling. All bearing surfaces hardened.

5 Handy pressure type grease fittings . . . same size for both swivel and wheel bearings. Fitting is permanently attached for life of caster. Easy to reach for fast, efficient maintenance. *No disassembly necessary for lubricating caster.*

6 Heavy gauge corrugated top plate . . . deeply embossed for maximum load capacity. Same size top plate and mounting hole c-c in all sizes of both rigid and swivel casters in this Series. Available in 3 different top plate and mounting hole c-c sizes, in 900GS Series Swivel Plate Casters.

7 Case hardened raceways . . . all bearing raceways are full hardened for years of trouble-free swiveling action. Top ball race welded to caster horn. Lower ball race accurately machined from solid steel bar stock. Precisely formed and fully hardened ball retainer with deep skirt fitted around balls in thrust bearing for high efficiency and long life.

8 Heavy gauge caster horn . . . full drawn steel horn will not bend under maximum loads.

9 Large diameter king pin . . . securely holds top plate and machined lower ball race cone in perfect alignment.

10 Wide choice of Faultless Wheel diameters and treads for load ratings up to 650 pounds per caster.

FAULTLESS 900GS SERIES GREASE SEALED CASTERS ARE AVAILABLE WITH HARD OR CUSHION TREAD WHEELS IN 5", 6" OR 8" SIZES

Manufactured by

FAULTLESS CASTER CORPORATION

Evansville 7, Indiana

Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Houston, Indianapolis, Los Angeles, New York, Philadelphia, St. Louis. Canada: Stratford, Ont.

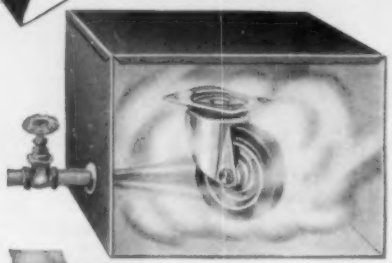
Faultless

VULCANIZED NEOPRENE GREASE SEAL

(PATENT PENDING)

Positive protection for swivel and wheel bearings wherever steam, dirt, chemicals, water are encountered

SEE HOW THIS GREASE SEAL WITHSTANDS HIGH-PRESSURE TESTS



Live Steam

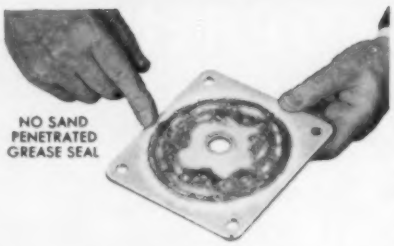
A stock 918-6GS Caster, with lubricated swivel ball bearings and wheel roller bearings protected by Faultless Neoprene grease seals is set upright in a steel box that is closed against air leaks. Live steam under pressure is piped into the metal box for a period of two minutes.

GREASE REMAINS INTACT AROUND BEARINGS

Faultless Caster swivel disassembled after steam test. Grease is still intact and giving full protection to bearings and raceways. The grease has not been thinned out by steam.

Sand Blast

The 918-6GS Caster is removed from the steam chest and set in a duplicate steel box with a ½" thickness of fine white sand on the bottom. Eighty pounds per square inch of pressured air is blown into the box, creating a swirling turbulance sufficient to force sand into the bearing areas of ordinary casters.



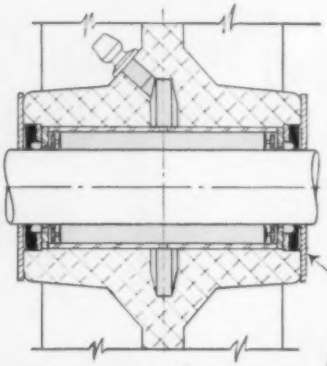
NO SAND PENETRATED GREASE SEAL

No particles of sand are present in the bearing assemblies. The Faultless molded Neoprene grease seal circumscribing and vulcanized to the upper ball raceway, and the metal cup covering the king pin and sealing the lower raceway are completely effective.

The severe steam and sand tests shown above prove the superior sealing qualities of the Faultless Vulcanized Neoprene Seal. In ordinary service the swivel and wheel seals will retain lubricants indefinitely. *The thin film of grease always present between the Neoprene rings and metal surfaces, positively reduces friction or drag and accelerates caster movement.*

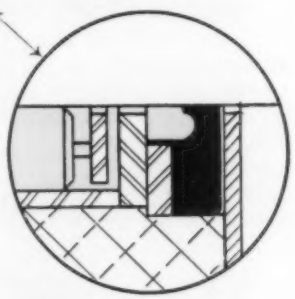
Old lubricants can be easily flushed out each time caster is relubricated—like changing oil in an automobile. Neoprene swivel bearing seal snaps back into snug fit after old lubricant is flushed out. Both wheel and swivel bearings are lubricated through separate pressure grease fittings of same type and size. No caster disassembly is necessary as on some types of grease seal casters.

Plant floors stay cleaner and safer—no dripping oil. Casters stay well lubricated for long periods of time under normal usage with grease retaining features of the Faultless Series 900GS Casters. These qualities make the Series 900GS an ideal caster for production line trucks, since trucks so equipped rarely are pulled out for maintenance. Faultless 900GS is also the best type caster where dirt, water, high or low temperatures, or brine conditions exist.



NEOPRENE HUB SEAL

Heavy Neoprene seal is formed around metal washer to lock grease within roller bearing. Washers with Neoprene are press-fitted into wheel hub. The Neoprene cross section reveals area provided to lock grease against leakage and to provide free running wheel.



SERIES 9700GS RIGID PLATE CASTERS are available with mounting hole spacings, top plate sizes, load capacities and overall heights to match companion Series 900GS Swivel Plate Casters listed below.

CASTER NO. WITH ROLLER BEARING WHEELS	WHEEL (Inches)	FACE (Inches)	KIND OF WHEEL	HUB LENGTH (Inches)	AXLE DIAM. (Inches)	LOAD CAP. EACH (Lbs.)	OVERALL HEIGHT (Inches)	SIZE OF TOP PLATE (Inches)	MOUNTING HOLE SPACINGS C-C (Inches)	DIAM. BOLT HOLES (Inches)	SWIVEL RADIUS (Inches)	APPROX. WEIGHT EACH (Lbs.)
906-5GS	5	1 5/8	Semi-Steel	1 5/16	7/16	550	6 1/4	5 x 5 1/2	4 1/8 x 4 1/2	25/64	4 5/16	6.5
*917-5GS		1 1/2	Rubber-tired	2	"	500	"	"	"	"	"	6
918-5GS		"	Vulcanized	1 15/16	"	200	"	"	"	"	"	5
923-5GS		"	Ruberex	"	"	300	"	"	"	"	"	5.75
929-5GS		"	Rockite	"	"	550	"	"	"	"	"	5
931-5GS		1 5/8	Plaskite	"	"	550	"	"	"	"	"	6
906-6GS	6	2	Semi-Steel	2 3/8	1/2	650	7 3/8	5 x 5 1/2	4 1/8 x 4 1/2	25/64	4 7/8	9
*917-6GS		"	Rubber-tired	2 7/16	"	650	"	"	"	"	"	7.75
918-6GS		"	Vulcanized	2 3/8	"	350	"	"	"	"	"	6.5
923-6GS		"	Ruberex	"	"	350	"	"	"	"	"	7
923-6B-GS		1 5/8	Ruberex	"	"	325	"	"	"	"	"	6.5
929-6GS		2	Rockite	"	"	650	"	"	"	"	"	6.5
929-6B-GS		1 5/8	Rockite	"	"	475	"	"	"	"	"	6
931-6GS		2	Plaskite	"	"	650	"	"	"	"	"	6.5
906-8GS	8	1 3/4	Semi-Steel	2 7/16	7/16	550	9 1/2	5 x 5 1/2	4 1/8 x 4 1/2	25/64	5 13/16	11
*917-8GS		1 1/2	Rubber-tired	2 1/2	"	500	9 5/8	"	"	"	"	8.5
918-8GS		2	Vulcanized	2 7/16	"	420	9 1/2	"	"	"	"	7
923-8GS		1 1/2	Ruberex	"	"	400	"	"	"	"	"	10
923-8 x 2GS		2	Ruberex	"	5/8	500	"	"	"	"	"	8
929-8GS		1 1/2	Rockite	"	7/16	550	"	"	"	"	"	10
929-8 x 2GS		2	Rockite	"	5/8	650	"	"	"	"	"	7
931-8GS		1 1/2	Plaskite	"	7/16	600	"	"	"	"	"	8.5

*Ball Bearing Wheel. Bolt and Nut Axles. Cadmium Finish.
Also available with top plate 5" x 5", mounting hole spacings 4" x 4". Add prefix "A"., e.g., A917-8GS.
Also available with top plate 4" x 7", mounting hole spacings 3" x 6". Add prefix "D"., e.g., D923-6GS.

For a demonstration of the Faultless 900GS Caster, and how it can overcome your particular problems, call your nearest Faultless Distributor or write to

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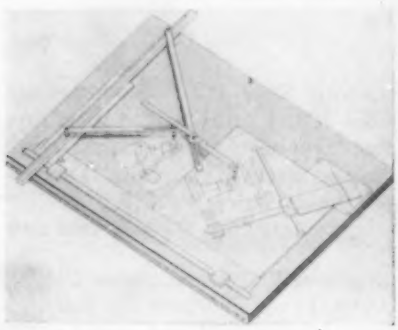
cations, as well as industrial automation. They are said to meet, and in many respects exceed, the requirements of Mil-E-5272 and Mil-E-5400.

A non-pendulous, truly linear response element eliminates cross talk and provides a completely basic linear output. The response elements can be housed in a variety of frames to meet mounting conditions and are available with potentiometer pickoff, inductive pickoff, or switches. Cedar Engineering, Inc., 5806 W. 36th St., Minneapolis 16, Minn.

For more information—
Circle 135, inside back cover



Pictorial View Drawn While Drafting

A drawing instrument is now available that produces an isometric, dimetric or trimetric drawing simultaneously with the drafting of conventional orthographic views. The instrument is a mechanical link system embodying a tracer-follower movement.

The illustration shows four drawings being completed, normal orthographics on right and a trimetric to left. Wilkinson Co., Box 638, Arnold, Md.

For more information—
Circle 136, inside back cover

Mechanical-Electronic Construction Kit

This kit's reinforced plastic carrying case with convenient handles can be used as a tote box for transporting from one laboratory position to another. When not in use, the precision parts can be stored in the case.

Available in three sizes, these kits are designed to meet the needs of engineering, industrial and university laboratories. Servomechanisms, Inc., 625 Main St., Westbury, N. Y.

For more information—
Circle 137, inside back cover

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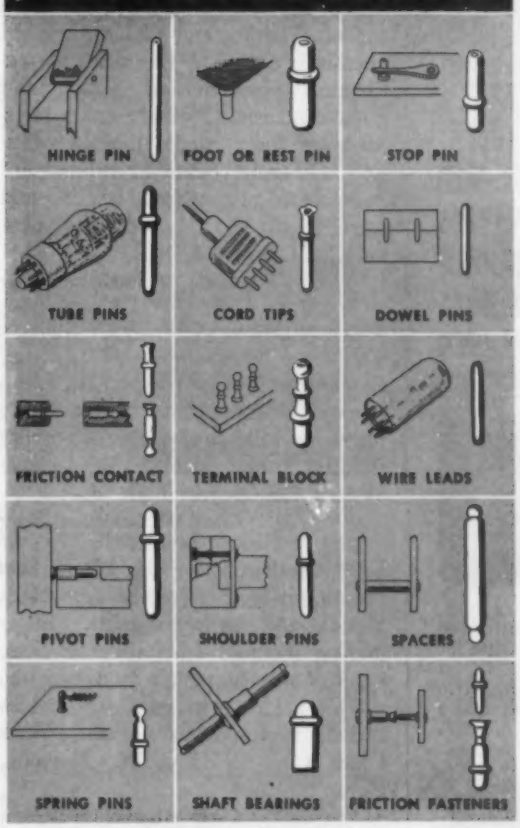

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Lock Washers—Catalog, 30 pp, describes line of fastenings that includes external, internal, heavy duty, countersunk, external-internal, dome, wide and narrow rims, twisted tooth designs. Locking action is described and illustrated and special uses of each available type of washer described. Sizes and dimension tables are provided. Shakeproof Div., Illinois Tool Works, St. Charles Road, Elgin, Ill.

Circle 138, inside back cover

Teflon Products—Bulletin 300, 11 pp, includes tables and descriptions of chemical, electrical, thermal and mechanical properties of Teflon and gives dimensions, weights and tolerances of sheets, tape, molded cylinders and bars, extruded tubing and rods, electrical spaghetti, beading and extruded shapes. United States Gasket Co., Camden 1, N. J.

Circle 139, inside back cover

Seamless Stainless Tubing—Bulletin TB-355, 6 pp, includes tables of analyses, mechanical properties, creep strength, physical properties, oxidation resistance of nine of the most popular stainless tubing steels. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 140, inside back cover

Wire Cloth—Catalog 55, 15 pp, lists various kinds of industrial wire cloth in rolls and fabricated parts. Information includes fabrication services, types of weaves, metals used, weights, market grades, wire gages and tables and charts of mesh sizes. Pequot Wire Cloth Co., 35 Hoyt St., Norwalk, Conn.

Circle 141, inside back cover

Industrial Papers—Catalog file of papers includes black paper laminated to foil, insulating papers, air filter paper, electronic board, separating papers and weatherproof bristol. Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y.

Circle 142, inside back cover

Universal Joints and Drive Shafts—Brochure, 4 pp, discusses advantages of line of needle bearing universal joints and shows design principles. Detroit Bevel Gear Co., 8130 Jos. Campau, Detroit 11, Mich.

Circle 143, inside back cover

Electrically Operated Valve—Brochure, 7 pp, has flow charts and description of valve for controlling large flow volume. Hays Mfg. Co., W. 12 St., Erie, Pa.

Circle 144, inside back cover

Stainless Steel Weld Deposits—Data Card 178, 1 pp, gives the stress rupture properties of chromium-nickel stainless steel weld deposits. Babcock & Wilcox, Beaver Falls, Pa.

Circle 145, inside back cover

Ruggedized Instruments — Catalog A38B, 11 pp, illustrates and describes line of ruggedized and sealed panel instruments in 1½, 2½, 3½ and 4½ in. sizes, a-c, d-c, RF and thermo, in both commercial and military types. Weston Electrical Instrument Corp., Newark 5, N. J.

Circle 146, inside back cover

Two-Circuit Limit Switch — Data sheet 104, 2 pp, describes switch used as a control for two independent circuits. Micro Switch, Freeport, Ill.

Circle 147, inside back cover

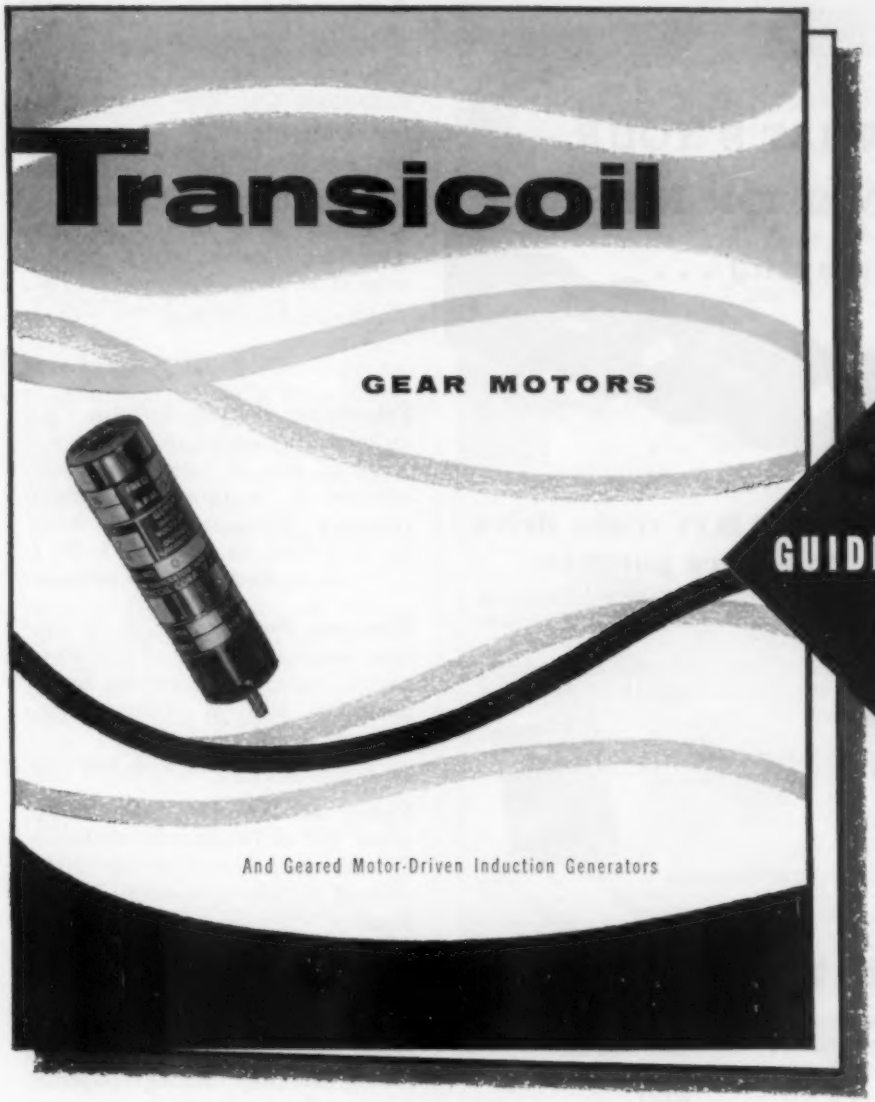
Magnetic Components—Booklet, 16 pp, describes variety of specialized magnetic components produced for use in electrical and electronic equipment. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass.

Circle 148, inside back cover

Flexible Metal Hose—Bulletin 50-B, 2 pp, describes twelve types of interlocking flexible metal hoses. Atlantic Metal Hose Co., Inc., 308 Dyckman St., New York 54, N. Y.

Circle 149, inside back cover

Hermetic Seal Connector—Bulletin, 2 pp, describes connectors that withstand mechanical shock of 100 G, thermal shock from —300 F to 500 F, bonding temperatures as high as 1000 F, operating pressures up to



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Circle 150, inside back cover

Vibration Isolation—Bulletin K3A, 4 pp, explains use of steel springs in controlling vibration, and describes a series of isolators. Korfund Co., Inc., 48-19C 32 Pl., Long Island City 1, N. Y.

Circle 151, inside back cover

Polyethylene Sheeting—Bulletin, 5 pp, includes information on current and suggested uses of heavy gauge polyethylene, its properties and chemical resistance. Celanese Corp. of America, 290 Ferry St., Newark 5, N. J.

Circle 152, inside back cover

Photocopy Paper—Folder, 6 pp, contains samples of a line of photocopy papers. American Photocopy Equipment Co., 1920 W. Peterson Ave., Chicago 26, Ill.

Circle 153, inside back cover

Casters and Wheels—Catalog, 28 pp, shows line of casters and wheels for light through heavy-duty use on all types of portable equipment. Rapids-Standard Co., Inc., Grand Rapids, Mich.

Circle 154, inside back cover

Stainless Steel—Data book, 16 pp, includes design and dimensional information on flange drilling templates, flange and ring-joint facings, stainless steel pipe, pipe threads, thread engagement; pressure-temperature ratings and conversion factors, resistance of fluid flow; hardness conversion tables, metal casting factors, physical and mechanical properties of stainless steel; a detailed materials selection chart covering more than 300 corrosive solutions. Cooper Alloy Corp., Hillside 5, N. Y.

Circle 155, inside back cover

Electrical Quick-Disconnect—Bulletin, 2 pp, contains information on how quick-disconnect works, and a description of the insulation material, pin and socket contacts. Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif.

Circle 156, inside back cover

Hydraulic Quality Steel Tubing—Bulletin 39, 6 pp, gives comparison of four specifications which have been used for pressure applications: SAE, JIC, AMS 5050 E, and ASTM-A-179.

Specifications for this company's SAE hydraulic tubing are also given in the table. Superior Tube Co., 1556 Germantown Ave., Norristown, Pa.

Circle 157, inside back cover

Solenoid Valves—Catalog, 20 pp, describes line of electrically controlled magnetic valves. Magnatrol Valve Corp., Hawthorne, N. J.

Circle 158, inside back cover

Photographic Film—Booklet, 6 pp, explains why photographic films change size and provides some dimensional stability data for both cellulose ester and polystyrene base film sheets. Eastman Kodak Co., Rochester 4, N. Y.

Circle 159, inside back cover

Gears—Brochure, 44 pp, illustrates the principal types of gears and miscellaneous combinations. Subjects covered include: cause of early tooth failure; simple physics of gear movement; shock loads, use of smaller gears for given loads; comparative action of gears having same pitch diameter; load errors costly to gear life; how incorrect teeth multiply gear loads; remedy for gear errors; methods of recording and charting gear accuracies; hobbing; gear shaving; microscopic observation of case depth; hardness testing; magnetic detection of gear defects; copper plating of gears to prevent carburizing leaks; broaching; heat treating techniques for high and low carbon steels; certification of gear accuracies. Sier-Bath Gear & Pump Co., Inc., 9252 Hudson Blvd., N. Bergen, N. J.

Circle 160, inside back cover

Electrical Controls—Booklet, 42 pp, was designed as a help in selecting electrical components for air conditioning, heating, ventilating, pump and compressor equipment. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee, Wis.

Circle 161, inside back cover

Thermostat Bimetal—Technical data sheet, 5 pp, supplies complete engineering data on ASC-3. It includes deflection curves. American Silver Co., 36-07 Prince St., Flushing 54, N. Y.

Circle 162, inside back cover

Zinc Coatings and Anodes—Booklet, 32 pp, contains drawings, charts and photographs together with brief comments on corrosion control characteristics of zinc coatings, zinc pigments

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and zinc anodes. American Zinc Institute, 60 E. 42 St., New York 17, N. Y.

Circle 163, inside back cover

Heavy Metals—Booklet, 20 pp, describes tungsten-copper-nickel alloy, twice as heavy as steel, 50 per cent heavier than lead. Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 164, inside back cover

Flow Regulation and Control—Catalog, 30 pp, describes flow regulators, solenoid valves, unloading valves, filters, check valves, Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.

Circle 165, inside back cover

Gears—Folders (2), 4 pp each, list line of fine pitch, precision ratchet, worm, spur, pinion and other types of gears, and also provide price list. Instrument Gear Works, 2815 W. Irving Park Road, Chicago 18, Ill.

Circle 166, inside back cover

Set Screws—Catalog 19, 24 pp, gives dimensions, prices, design details of socket screws, pipe plugs. Set Screw & Mfg. Co., Bartlett, Ill.

Circle 167, inside back cover

Three-Dimensional Cams—Folder, 4 pp, describes cams for automatic control, instrumentation, providing both theoretical and design points. Parker Stamp Works, Inc., Franklin Ave., Hartford, Conn.

Circle 168, inside back cover

Woven Heat Elements—Folder, 4 pp, describes construction, characteristics, applications of woven wire heating units. Safeway Heat Elements, Inc., 680 Newfield St., Middletown, Conn.

Circle 169, inside back cover

V-Belts—Catalog, 24 pp, describes steel cable, open and hexagon V-belts as well as V-link belting. Maurey Mfg. Corp., 2907-23 S. Wabash Ave., Chicago 16, Ill.

Circle 170, inside back cover

Solenoid Valves—Catalog 101, 4 pp, includes drawings and specifications of a floating seal solenoid valve. Valcor Engineering Corp., Carnegie Ave., Kenilworth, N. J.

Circle 171, inside back cover

Voltage Regulators—Bulletin 5.02, 2 pp, has details on both a-c and d-c

compensated units for voltage regulation. Electric Regulator Corp., 502 Pearl St., Norwalk, Conn.

Circle 172, inside back cover

Spring Design–Data sheets, 8 pp, contains basic considerations in designing precision springs. Line drawings, graph and formulas are used to describe various types of springs and spring design criteria. Hunter Spring Co., Lansdale, Pa.

Circle 173, inside back cover

Hose Couplings–Catalog 100, 31 pp, describes hose assemblies and fittings for low, medium and high pressure and suction. Anchor Coupling Co., Inc., E. Church & 4th St., Libertyville, Ill.

Circle 174, inside back cover

Hydraulic Pumps–Bulletin H3A1, 11 pp, describes pumps of 1/5 to 30 gpm ratings of following types: positive displacement, gear type, fluid motors. Webster Electric, Racine, Wis.

Circle 175, inside back cover

Drafting Equipment–Catalog, 32 pp, provides a buying guide for drafting machines, drawing boards, T-squares, parallel rules, triangles, templates, curves and lettering aids. Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Circle 176, inside back cover

Glass Fiber Filters–Bulletin, 4 pp, pictures and describes filter discs and gives shapes, fiber diameters, disc diameters, disc thicknesses and disc densities available. Friedrich and Dimmock, Inc., Millville, N. J.

Circle 177, inside back cover

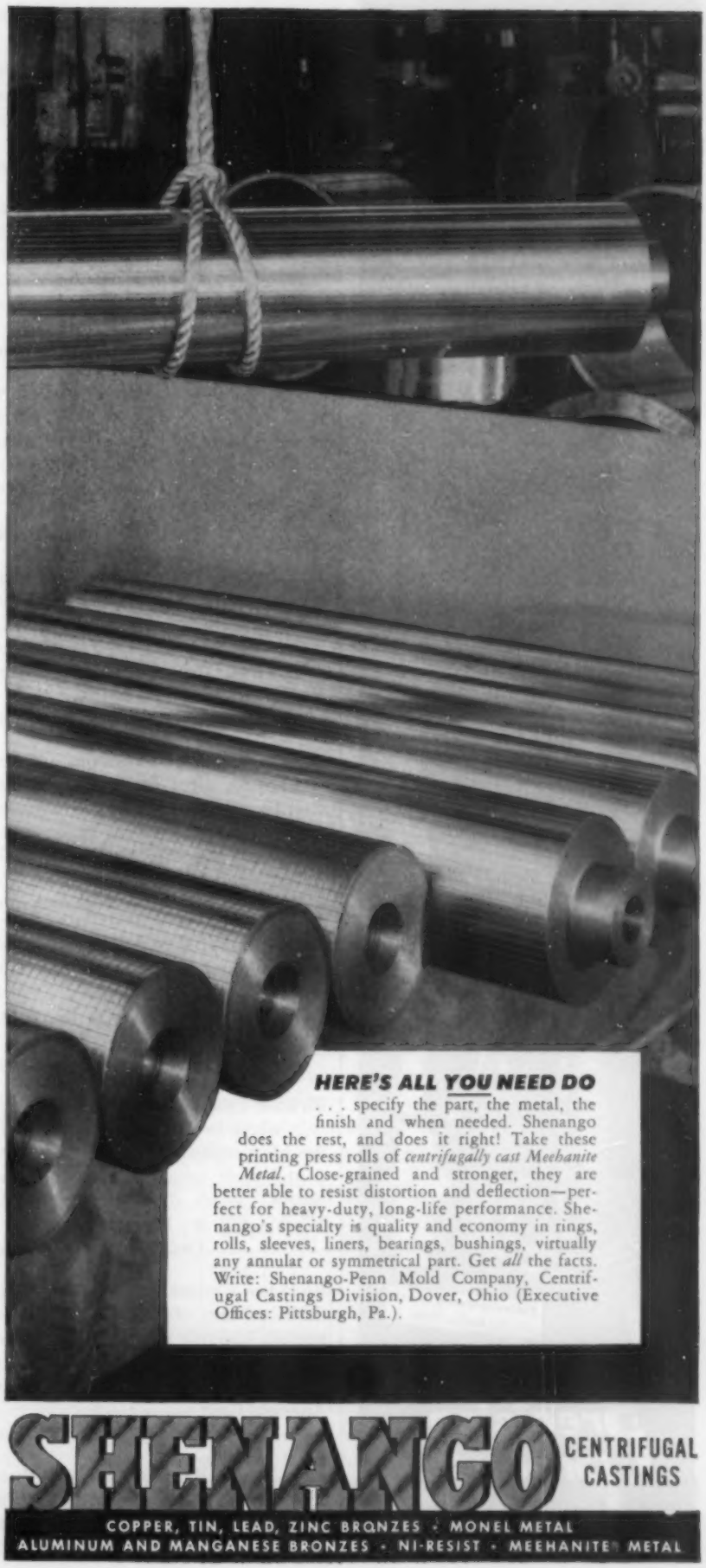
Strainers–Bulletin 240, 4 pp, describes a straight line strainer for pressures up to 150 psi. Included are flow and dimensional charts. Hays Mfg. Co., W. 12 St., Erie, Pa.

Circle 178, inside back cover

Variable Speed Drive–Bulletin K-200, 8pp. Description, ratings, dimensions and other engineering data on all models of this variable speed drive are provided. Cleveland Worm & Gear Co., 3249 E. 80 St., Cleveland 4, Ohio.

Circle 179, inside back cover

Worm Gearmotors–Catalog 46-C, 67 pp, provides specifications, selection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. . . specify the part, the metal, the finish and when needed. Shenango does the rest, and does it right! Take these printing press rolls of centrifugally cast Meehanite Metal. Close-grained and stronger, they are better able to resist distortion and deflection—perfect for heavy-duty, long-life performance. Shenango's specialty is quality and economy in rings, rolls, sleeves, liners, bearings, bushings, virtually any annular or symmetrical part. Get all the facts. Write: Shenango-Penn Mold Company, Centrifugal Castings Division, Dover, Ohio (Executive Offices: Pittsburgh, Pa.).
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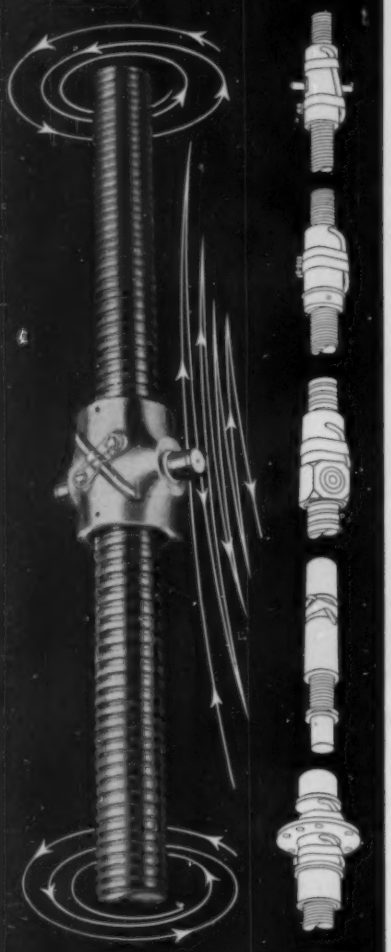
beaver ball screws

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.



Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

data, rating tables, price lists, dimensions and weights. D. O. James Gear Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill.

Circle 180, inside back cover

Automatic Valve Positioner–Bulletin F5991-1, 2 pp, describes positioner for use in conjunction with any control instrument having a "high" and "low" contact with a neutral position. Barber-Colman Co., Rockford, Ill.

Circle 181, inside back cover

Alkyd Molding Compounds–Folder, 4 pp, presents data on granular, putty, and glass-reinforced compounds. Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Circle 182, inside back cover

Engineering Research and Development–Booklet, 30 pp, describes development of automatic assembly machine. Mechanical Div., General Mills, Inc., 1620 Central Ave., Minneapolis, Minn.

Circle 183, inside back cover

Valves, Fittings, Accessories–Catalog R-5, 24 pp, gives size and application data for a line of fittings for refrigeration and air conditioning applications. Superior Valve & Fittings Co., 1509 W. Liberty Ave., Pittsburgh 26, Pa.

Circle 184, inside back cover

Polar Relay–Bulletin RH, 6pp, gives electrical characteristics, travel time, and other details. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle 185, inside back cover

Flexible Couplings–Bulletin 53, 4 pp, tells where to use and how to specify flexible couplings, to eliminate accidental shaft misalignments and load shocks. Smith & Serrell, Inc., 200 Washington St., Newark, N. J.

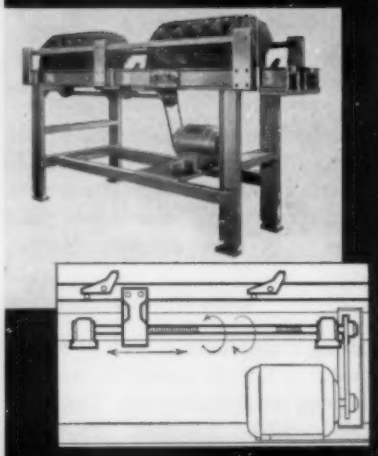
Circle 186, inside back cover

Electrical Connectors–Bulletin, 4 pp, describes line of AN electrical connectors, covering performance requirements, size and capacity, basic parts. Deutch Co., 7000 Avalon Road, Los Angeles, Calif.

Circle 187, inside back cover

Fans and Blowers–Catalog sheet 20201-5, 2 pp, provides mathematical method of selecting the proper type of fan or blower for electronic ap-

The same principle used in raising landing gear automatically shuttles engine blocks



Beaver Ball Screws were selected by Spurgeon Co., Van Dyke, Michigan, for this device which synchronizes transfer of engine blocks between production machines—WHY?

1. *Superior in performance and wear to Acme screws. Less power required.*
2. *Costs less to install and maintain than hydraulic cylinder. No oil leakage.*
3. *Costs less than air cylinder and costs less to maintain. Operates smoother. No air hookup required.*

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

plications. Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.
Circle 188, inside back cover

Tool Steels—Brochure, 70 pp, gives technical data on more than 50 types of tool steels and cold finished products. Vanadium-Alloys Steel Company, Latrobe, Pa.
Circle 189, inside back cover

Stainless Wire, Rod, Strip—Handbook, 40 pp, covers in detail the properties, specifications, applications and design data on 20 grades of stainless steel wire, rod and strip. Alloy Metal Wire Div., H. K. Porter Co., Inc., Prospect Park, Pa.
Circle 190, inside back cover

Ball and Roller Bearings—Bulletin A-638, 52 pp, contains technical information and list prices on line of ball and roller bearings and pillow blocks. Tabular data includes engineering drawings, dimensions, shaft sizes, weights, radial load ratings. Dodge Mfg. Corp., Mishawaka, Ind.
Circle 191, inside back cover

Relays—Catalog 55, 11 pp, includes range of short and long form telephone type relays for ac and dc, subminiature d-c relays, improved latch-in relays of extraordinary versatility, relays with bifurcated (twin) contacts, miniature relays with heavy current contacts, relays with time delay, plug-in relays, relays with snap action contacts, and 400 cps relays. Magnecraft Electric Co., 3350Y W. Grand Ave., Chicago 51, Ill.
Circle 192, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Program Control—Bulletin 1130, 22 pp, describes methods and advantages of employing automatic, time-conditions control for industrial processes and tests. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

Gear Design—Handbook, 145 pp, contains tables, charts, diagrams, formulas, curves for use in design of gears and geared assemblies. D. O. James Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill.

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Quality – performance – economy! That's the combination you need to stay ahead in today's highly competitive fan market. Our Model "B" 4-Pole, 4-Coil motor was designed specifically for household fan applications. Tested and proved *in the field*, its smooth, quiet, trouble-free performance has won it the enthusiastic approval of leading manufacturers everywhere. The Model "B" features self-aligning, self-lubricating bronze bearings; dynamically balanced rotor; baked varnish-impregnated windings; ample oil reservoir located for easy lubrication. See table below for size range (modifications available, in production quantities, of course). Write today for complete specifications and prices.

MODEL	HP 1500 RPM	Locked Rotor Torque In/Oz	Max. Running Torque In/Oz	Free Speed RPM	Watts 1500 RPM	Amps 1500 RPM	Weight Lbs.
B-5-CW B-5-CCW	1/80	2.2	9.0	1720	44	.67	2.0
B-8-CW B-8-CCW	1/60	2.7	13.0	1745	56	.80	2.7
B-10-CW B-10-CCW	1/50	3.0	15.5	1755	64	.88	3.1
B-12-CW B-12-CCW	1/40	3.4	18.0	1760	72	.95	3.4

NOTE: Direction of rotation when looking at end of shaft. CW indicates Clockwise. CCW indicates Counter-clockwise.

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Pictured, Cramer Hi-Model 4D-22T with forward-tilt seat; others available. All are low-gravity balanced for safe use on casters if desired.

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Please send me complete facts on the Cramer Hi-Model chairs designed for working architects and engineers.

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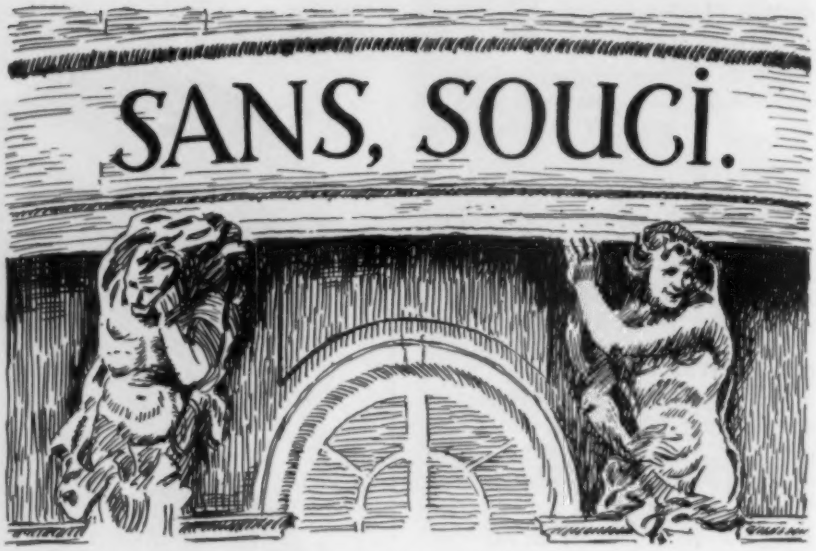


Ad Libbing by the Editor

Although most social formalities can be traced back to a semilogical origin, few people ever think about the causes that established the formality. The gentleman tips his hat without ever thinking that the custom stemmed from the knights of old who took off their metal helmets when meeting a friend. This action indicated that he was not afraid that his friend might hit him over the head with a cudgel. And of course, in every instance the knight took off his helmet when he met a lady fair to show that he was not afraid of her.

Today the American man does not tip his hat upon meeting another man, not even his best friend. Does that indicate that in America no man trusts any other man? Maybe so but probably not, yet, in some parts of Europe men still tip their hats to each other.

Politeness is often empirical. So are some of the sayings we have. We hear the same thing over and over again until we believe it. The more illogical, unreasonable and fantastic it is, the quicker we believe it. As Hitler said, "If the lie is big enough everybody will believe it." Often the statement is not presented as an untruth but is in fact based on misinformation or misunderstanding. But the same principle applies. If the statement is made often enough and with enough emphasis, true or not, we believe it. That is one of the fundamentals of propaganda.

When I prepared for this trip to Europe many of my business associates said, "Oh! you won't have any trouble with languages. All the Germans speak English." In view of the fact that I speak German fluently, I did not care whether or not anybody in Germany spoke English. Naturally I was interested in hearing the statement and for the following reason I did not question the accuracy of the assertion that all Germans spoke English.

When I heard them say that, my mind went back to 1913 when I visited Germany and spent most of my time among the seaport towns of Hamburg and Bremen where most people spoke English as well as German. So it was not difficult for me to believe my associates who could not speak German but assured me that everybody whom I might meet in Germany could speak English.

Then Came the Dawn

When I arrived at Hamburg, Germany, I found as I had in 1913, that almost everybody, shopkeepers included, could speak English fairly well. In Bremen I found the same situation. But as I went on to Düsseldorf, Frankfurt and Munchen or Munich, as it is called in English, I noticed fewer and fewer people spoke English. Were my associates wrong??? Surely they would not fool me!!! And then came the dawn.

Of course my associates found that practically everybody in Germany spoke English. Of course they did. The only people who would speak to them were those Germans who could speak English. It made me feel awfully stupid to think that I had believed, to some degree, what my associates had expounded as a proven truth. As so often happens, they had spoken

HOWELL MOTOR BRIEFS

Quick facts for those who design-in and specify electric motors

Disc Motors . . . Space Savers Unequalled!

Here's the way to reduce the space occupied by a motor and still get performance characteristics equivalent to those of a conventionally designed motor. Depending upon horsepower, Howell Disc motors will effect length reductions of between 42 and 50 percent, with only a very slight increase in overall diameter.

This drastic space saving results from flattening the end plates and recessing the bearings into the motor. Howell is one of the few manufacturers who furnish disc motors (sometimes called "pancake" or "wafer-type") as a standard item.

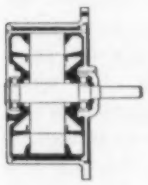


Fig. A

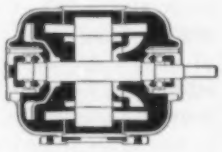


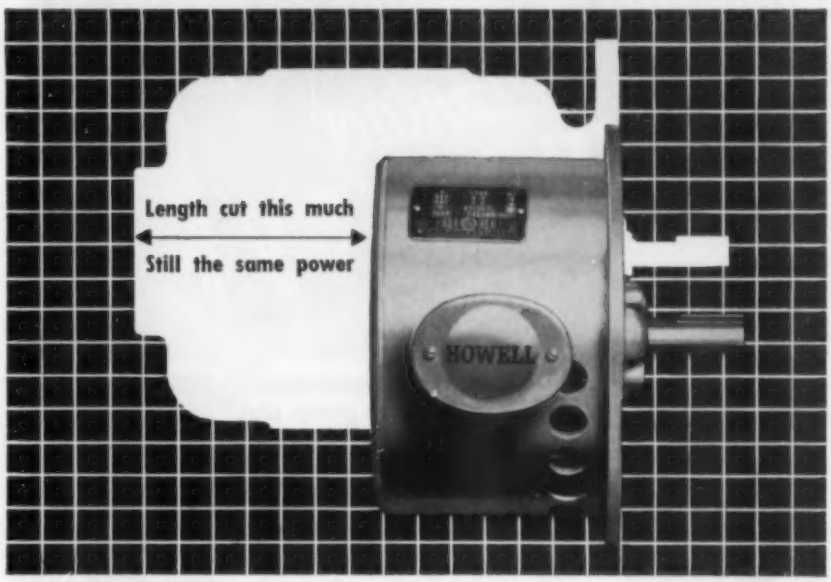
Fig. B

Fig. A, showing the Howell disc motor design, illustrates how the bearings are recessed into the rotor. Compare this with Fig. B, showing conventional motor construction. Both designs provide ample copper wire and lamination steel in the motor.

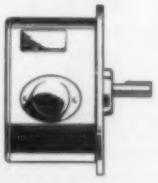
As compared to other disc motors having the rotor recessed into the stator, Howell's disc motor design has these advantages: (1) Effects a greater reduction in size; (2) Has no axial air gap to vary and cause motor "howl" or power loss, when bearings wear over an extended period; (3) Service, if ever needed, is simplified because of the conventional rotor and stator construction.

It's a tried and proved design — Howell Disc Motors have been used with excellent results on machine tools, punch presses, cranes and hoists, among many other applications . . . and new uses are being developed constantly. Because there are no ventilation ports in the end plate at the pulley end of an open-type disc motor, it's ideal for vertical, shaft-up mounting.

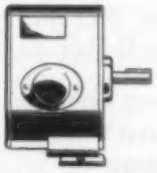
Howell can furnish all the electrical types available in conventional motors — multi-speed, high torque, high slip; single or polyphase; Class "B" or "H" insulation included. They're readily combined with the Howell friction brake to make an extremely compact and efficient type of brake motor.



They are offered as standard motors in Frame sizes 56 through 32, both in open and enclosed, fan-cooled constructions. Mountings: either NEMA "C" face end plates or foot-type as illustrated.



FLANGE MOUNTING



FOOT MOUNTING

Sizes range from ¼ to 20 h.p. at 1800 rpm, including intermittent hoist types.

Write for Bulletin DT-1

Howell's distinctive motor construction, as applied to the disc type motor, includes such features as these:

High-quality insulation. Seven different pieces of insulation for each slot cell. Complete insulation between top and bottom coils and between all phase groups. Lead wires brazed to coil ends and insulated with vinyl chloride plasticized fiberglass tubing.

Copper-clad rotor. Copper bars and end rings are welded or brazed together for unusual strength. High melting point of copper prevents damage from high temperatures caused by possible over-loads.

Expert craftsmanship. Rotors are ground to precision limits for exact concentricity and uniform air gap. They are dynamically balanced at rated speeds.

High-quality coil varnish. Entire stator is thoroughly impregnated twice with the finest phenolic resin-base varnish, twice baked for extra protection.

Leakproof oil seals. Provide dependable, dirt-free operation.

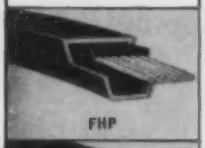
HOWELL Red Band MOTORS

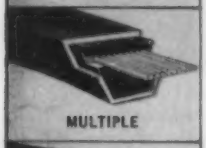
HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Mor-Grip v-belts


FHP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SUPER RATED

STEEL CABLE

OPEN END

HEX BELTS

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Maurey *engineers* v-drives for every situation; the "stop and go" spurts of refrigeration drives; the pulsating, high torque loads of rock crushing; the smooth, steady-pull of textile drives... for short centers, and wide range of speed ratios. Maurey V-drive equipment has proved its value since 1917, improving the performance, and increasing the sales of thousands of products. Maurey delivers pulleys, belts and accessories *quickly* from complete stocks. Whether you are designing a new v-drive or improving an old one, contact Maurey. Call your local Maurey Distributor, or write direct.

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with an air of profound authority on a subject about which they could know nothing. If they could not speak German, how did they know that "almost everybody you meet can speak English?" Obviously the Germans who could not speak English would steer clear of an American who could not speak German. This fact was evidenced to me repeatedly.

In one plant I was sitting in the works manager's office, having an interesting discussion. He said I ought to meet the chief engineer, and he immediately dialed him on the phone. A few words were exchanged in German and then the works manager started laughing, placed his hand over the transmitter and said to me, "He thinks you can't speak German." Over the phone he said, "But this man is an American engineer who speaks German." The three of us had dinner together that night.

Anybody who says that German engineers and scientists are secretive, uncooperative and even antagonistic toward Americans just doesn't know what he is talking about. The whole attitude of German engineers toward American engineering was summed up by one of the Germans. "Before World War I—we thought we knew it all. After that and until World War II, we conceded that American technologists might be able to show us a few things. Now we know that during World War II German technological developments practically stood still, we know the Americans are away ahead of us and we are anxious to get from them all we can. That is why we are willing to tell about our design developments."

Wherein the British

In England I also had a number of eye opening experiences. The British Iron and Steel Research Association has no counterpart in the U.S.A. The Napier Company is doing great pioneering in gas turbines, and Austin Motor Car Co. just came out with a gas turbine driven passenger car. In jet propulsion the British are still in the front seat.

Over in Holland one sees a hard working courageous people doing an engineering job the like of which is not found elsewhere in the whole world. More later.

During the coming months we will give you all the details. G.F.N.

ABSTRACTS

Sandwich Panels: Assembly, Construction and Uses

Abstracted from "Sandwich Panels: Assembly, Construction And Uses" by A. J. Douglas, Manager, Products Development, Winner Mfg. Co., Inc., presented at Eleventh Annual National Technical Conference of the SPE, Atlantic City, N. J., Jan. 1955.

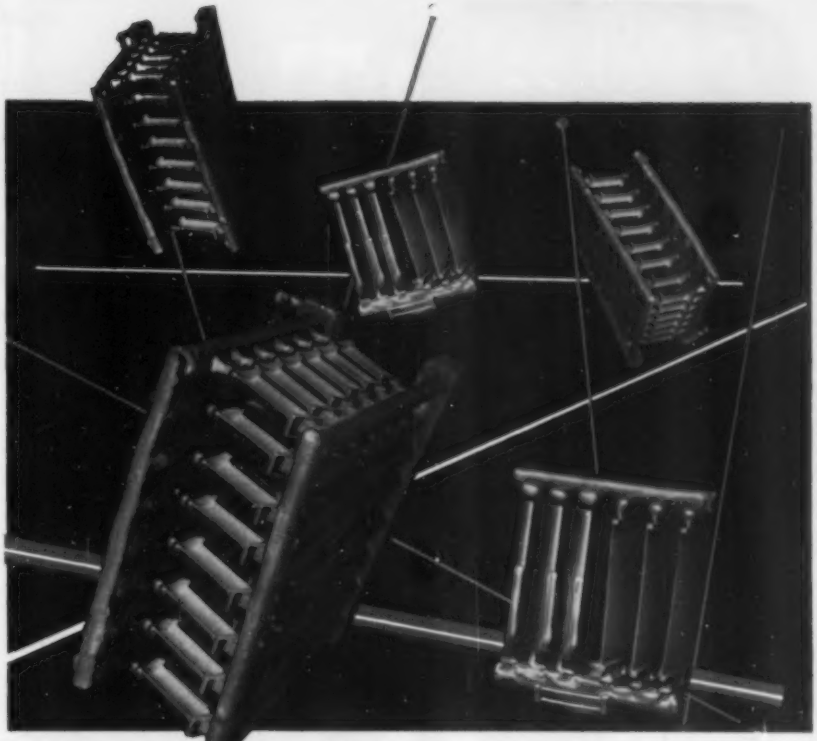
The sandwich panel as we know it consists of two skins or facing sheets, usually of similar material to eliminate distortion, bonded to both sides of a light-weight core with a structural adhesive. Each sandwich construction must be designed with that combination of materials and geometry which best satisfies engineering, manufacturing, service needs.

The first step will be to choose the proper core material which stabilizes the facings and resists compression and tension perpendicular to the faces, prevents buckling and maintains the panel in a fixed position. Balsa wood might be one choice; it has been used successfully since it has a high uniform compressive and tensile strength, good bonding characteristics and is light in weight. Foamed plastics have been developed to overcome the disadvantages of balsa wood and these are generally foamed in place between the preformed sheets. The cellular core eliminates the need for joints in panels of various sizes and has excellent dielectric properties. In the foamed material the smaller the cell size the greater the bending modulus and compressive strength, but also the higher the density.

Paper honeycomb may be used in panels of semi-structural requirements. It is light in weight, has good insulating values, is normally impregnated with resin to make it fungus and moistureproof, and low in cost.

Cotton cloth honeycomb has fair compressive strength and moderate moisture resistance and can be used for structures of limited support. Fiberglas honeycomb has low moisture absorption and excellent dielectric properties making it applicable for radar antenna housings.

Waffle-type core material composed of resin-impregnated glass fiber fabricated into a configuration resembling a waffle has been developed



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These are the three fundamentals of Austenal production. Only all three brought together can guarantee the finest investment-cast parts for American defense and industry.

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These three factors of sound production can work effectively for industry. Austenal has solved many industrial problems where fine, accurate and dependable cast parts were required for efficiency as well as economy.

Depend upon Austenal's greater skill, versatility and experience when you need investment castings. These are your assurance of the finest precision cast parts.

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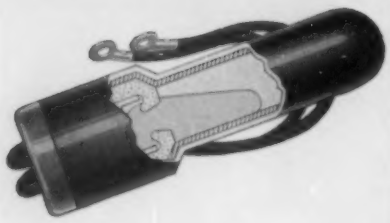

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ALL-STEEL MERCURY SWITCHES

primarily for radomes where exact thickness is of prime importance.

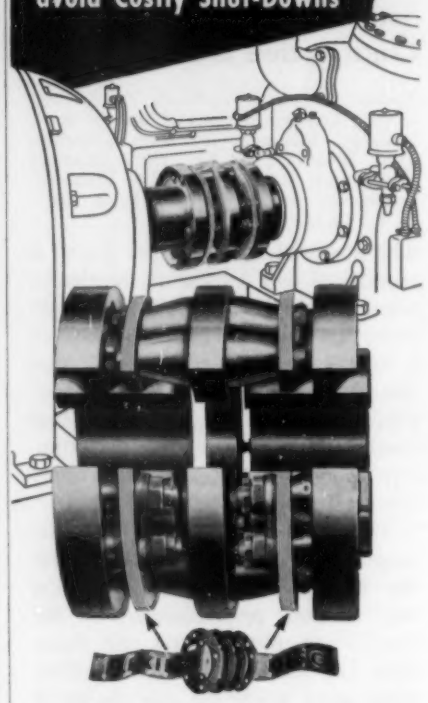
Stainless steel honeycomb is used for extremely high strength and thermal requirements, but the variety of foils available is limited and this necessarily limits the usefulness.

Aluminum honeycomb is highly resistant to temperature extremes, moisture, corrosion, and fungus. It is available in many foil thicknesses and several cell sizes which make it most adaptable for multiple uses.

The skins or facing materials normally are laminated paper, cotton cloth, fiberglas, galvanized sheet, stainless steel, magnesium or aluminum and lately even window glass for decorative use. Facing materials may be used in any combination but since they carry the major load they must be chosen with care. Stiffness, configuration, stability, and the strength of the member are also determined by the characteristics of the skin. Resistance to impact is almost wholly dependent on the face materials and not on the thickness of the panel. The stiffer the face material the more it spreads the impact force over the core and the larger the force which can be absorbed without damage. The skins may be selected to furnish a smoooth surface, a non-skid face, they may be decorated or embossed, or provide a surface to be bonded later with a face-coating for additional toughness. Care must be taken during the handling of the sheets since a dent, wrinkle, or half moon impression could lead to a stress concentration and cause premature failure of the finished panel.

The sandwich panel is only as strong as the bond between core and skin. It is only due to the recent adhesive developments that we are able to accomplish the bonds we do and attain unusually strong structures. The adhesives may be polyvinyl butyral phenolic, phenolic, epoxy, polysulfide elastomer modified epoxy, and di-isocyanate. They may be of the room-temperature curing type, high heat cures, unbacked or cloth or tape carried. They may be spread by brush, sprayed, roller-coated, troweled, or applied mechanically. The pressures necessary for bond may be anything from vacuum and contact pressure to 500 psi while the curing temperature may be from ambient to 300 F. It

Specify **THOMAS** ALL METAL **FLEXIBLE COUPLINGS**
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

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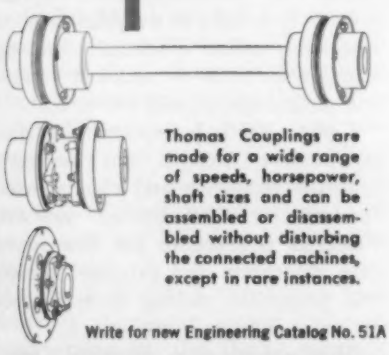
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



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is necessary to know how the cured adhesive will react under temperature and humidity variations, what its creep properties are, how it will maintain its characteristics under impact and fatigue. Most of the adhesive manufacturers publish information sheets that make the job of choosing the adhesive a little easier. But the adhesives, as the core and facing materials, must be chosen to do the required job at the permitted cost.

Sandwich panels employ the best combinations of available materials to satisfy demands of stiffness, rigidity and lightness while considering cost and manufacturing methods. The most practical approach demands that we recognize the need for high flexural strength and rigidity and limit ourselves accordingly. As face thicknesses increase, the panel becomes stronger, stiffer and heavier, therefore, plan to reach the optimum strength for weight ratio. For boards of given weight, width and span, the flexural stiffness will be directly proportional to the flexural modulus of elasticity of the composite panel and indirectly proportional to the cube of the average specific gravity.

Past performance has proven that for optimum weight design in sandwich panels using honeycomb core, it is best to have the skins approximately 1/10 the panel thickness and the weight of the facings approximately 65 per cent of the total panel weight. By using these simple proved facts it is possible to roughly design a honeycomb panel of minor design very easily. For more elaborate structures it is necessary to plan a solid structure and convert to a honeycomb structure by comparing the section modulii, and check for deflection.

Magnetic Amplifier in Processing Line Loop Control

Abstracted from "Utilizing the Magnetic Amplifier for Processing Line Loop Control" by K. S. Yamamoto, Associate Member AIEE, Clark Controller Co., Cleveland, Ohio; presented at the AIEE Winter Meeting.

Many strip processing lines require certain sections of the line to be unaffected by the operations performed in the adjacent sections of the line. Since the material is of a

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- allow large weight savings
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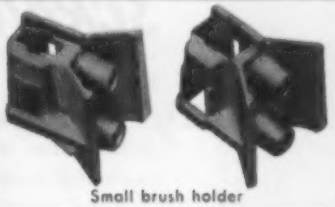
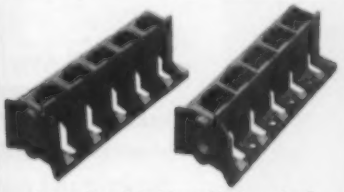
VISUAL PROOF

These photos demonstrate how little secondary machining is required on typical Titan pressure die castings. In each case a part as cast and trimmed only, and the same part machined are shown.

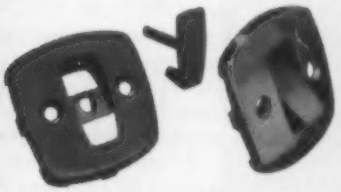
Flywheel for garbage disposal unit



Small brush holder



Large brush holder with broached holes held to close tolerance



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continuous nature any distorting drag upon the material would be transmitted by means of the material between adjoining sections. To eliminate this effect the material is permitted to hang in slack loops between the two adjacent sections of the line. Thus the loop forms a loose coupling between the two sections to permit completely independent operation.

Generally there are two reasons for using a loop as a coordinating means —i.e. storage and alignment.

Loops for alignment purposes vary from three to ten feet in depth. Loops for storage are considerably deeper and often hang in looping pits.

The depth of a loop must be maintained essentially constant. Any system disturbance which causes an incremental change of material speed on one side of the pit, causes the loop length to vary. This change in length can be detected, used as a signal, and applied to a regulator. The regulator adjusts the field excitation of one of the motors driving the strip and corrects the speed of the strip to return the loop catenary to its proper position.

In systems where material is wound from a large reel into the pit, the reel speed must be continually varied. As the peripheral speed of the reel changes with the diminishing reel radius, the speed of the reel driving motor must continuously increase to compensate. In systems where the material is taken from the pit and wound on the reel the motor speed must be decreased.

The magnetic amplifier can be used as the basic element of a regulator. It is a rugged, static device, requires a minimum of maintenance and has a long life. No warm-up period is required as the magnetic amplifier becomes immediately operative upon the application of power. Input and output circuits are electrically isolated, permitting the formation of multi-stage cascaded units.

The basic signal for detecting the loop position is obtained from a battery of photocells mounted one above the other. Light for these photocells are obtained from a bank of lamps mounted on the opposite side of the looping pit.

The output of the photo tubes is proportional to the position of the

loop. The loop, in modulating the light reaching the photo tube, causes a stepless variation in the current flowing in the photo tube circuit.

For accessibility and easy maintenance, the balance of the loop control is usually mounted at some remote point. A sensitivity control fixes the amount of light necessary to change the field voltage over the desired range. The loop control does not hold the loop in one fixed position but permits the bottom of the loop to change gradually within certain limits of the beam determined of the sensitivity network.

A position control fixes the position of the loop within the operating range of the light and phototubes during normal operation.

A center tapped d-c control winding of a magnetic amplifier is connected in the plate circuit of the main tube. The current in this winding is then controlled by the signal from the phototubes.

The first stage of the magnetic amplifier is constructed for high sensitivity. It is provided with windings for signal, reference, anti-hunting and feedback, and is connected as a full wave self-saturating bridge type magnetic amplifier. The rectifiers used in the saturating legs of the reactor exhibit extremely high inverse resistance and low forward resistance. The output from the first stage feeds the control winding of the second stage. The second stage is a large power output magnetic amplifier as opposed to high sensitivity. The power from this stage is used to energize the field of the motor driving the strip.

This is a complete closed-loop system. The signal is obtained from the loop modulating the light source which in turn operates the motor driving the material which has formed the loop. The loop control can be used for either "pay off" or "wind up" systems with simple alteration in the circuit.

In some applications where it is impossible or impractical for the operator to visually see the bottom of the loop a position indicator is used. This is a specially calibrated voltmeter, which is connected into the control to provide a visual indication of the exact loop position.

In other applications relaying circuits may be desirable to provide for adjustable acceleration, deceleration.

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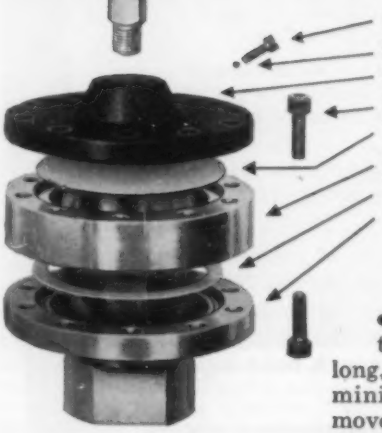
FEATURES



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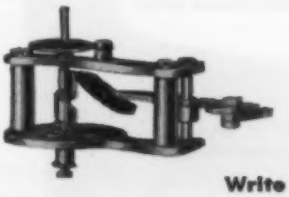

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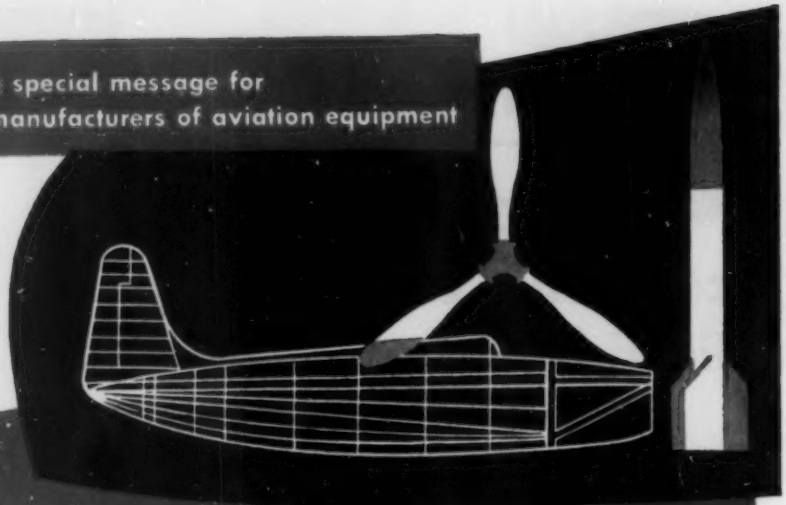

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NEW BOOKS

Flexure Devices

P. J. GEARY, *British Scientific Instrument Research Assoc.* 6 x 9½ *in.*, 44 *pp, paper-bound. Published by the British Scientific Instrument Research Assoc., Information Dept., 'Sira,' Southill, Elmstead Woods, Chislehurst, England.* 10/6d *post free, (about* $1.50).

This is the first of a series of surveys of the literature on functional units in instruments. Flexure pivots, movements and suspensions were chosen as the subject of the first of the series because these useful devices for supporting and constraining movable members seem little known outside limited circles; because earlier quick searches for literature on the subject had shown that such literature was widely scattered among many publications and that there was no one comprehensive text or extensive bibliography; and because the subject. being fairly clearly defined and without a voluminous literature, seemed well suited to the first—and to some degree trial—unit in a series of publications.

The booklet comprises essentially an illustrated technical introduction, followed by digests of 28 selected important publications on the subject and a separate annotated list of 111 references to texts of secondary importance, together with such indexes as are necessary to make the compilation easy to use. Each succeeding publication is expected to retain this format. Periodical, book and report literature has been searched methodically, but patent literature has not, although digests of some patent specifications have been included.

The bulk of the material in this booklet has been arranged in three separate sections—technical introduction, digests of important texts, list of less important texts—to meet the needs of three different classes of reader. Those who need only a brief general survey of the subject may satisfy their needs by reading the introduction and studying the accompanying diagrams; readers who require

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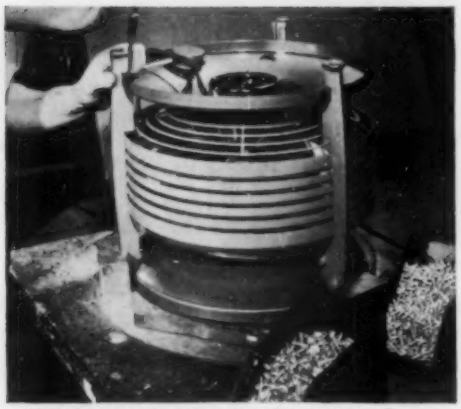

"ASSEMBLY IMPROVED IMMEDIATELY when we began using Phillips screws," relates the assistant purchasing agent of Fasco Industries, Rochester, N. Y., leading makers of shaded pole motors, blowers, fans and ventilators. "Now we can use mechanical drivers that save plenty of time. Burring seldom happens any more. Product appearance couldn't be better. Whether inside for extra sturdiness, or outside for extra dressiness, we use Phillips screws almost exclusively!"

MORALE AND PRODUCTION SOARED with changeover to Phillips screws, which now comprise more than 92% of all screws used at Yankee Metal Products Corporation, Norwalk, Conn. Makers of auto lamps, mirrors and safety equipment since 1915, Yankee depends on many types of Phillips heads — both unplated and chromed to match accessories. Yankee's Merchandising Director says happily, "Phillips screws for extra safety, speed and ease of use really build plant morale and incentive earnings!"

EXTREME ANGLES NO PROBLEM where tightness is vital as in this fan assembly built by leading small motors manufacturer A. C. Gilbert of New Haven, Conn., to withstand lifelong vibration. Single-slot screws proved treacherous and expensive in time and damage loss. An executive engineer for Gilbert says, "Using Phillips screws for over 10 years, we have learned that, for all around production efficiency, Phillips are the best."

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more detailed knowledge will study also some or all of the digests of the most important papers; those making a thorough study will peruse in addition the secondary texts, which will also be of special value—when used in conjunction with the subject index—to anyone wishing to pick out all the texts dealing with one kind of device or application, but to ignore the rest. Although the division of material into "more important" and "less important" is a hazardous undertaking it seemed worth while trying to lighten the task of the reader in this way.

Dictionary of Metallography

R. T. ROLFE, 5½ x 8¾ *in.*, 287 *pp. Published by Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y.*, $5.75.

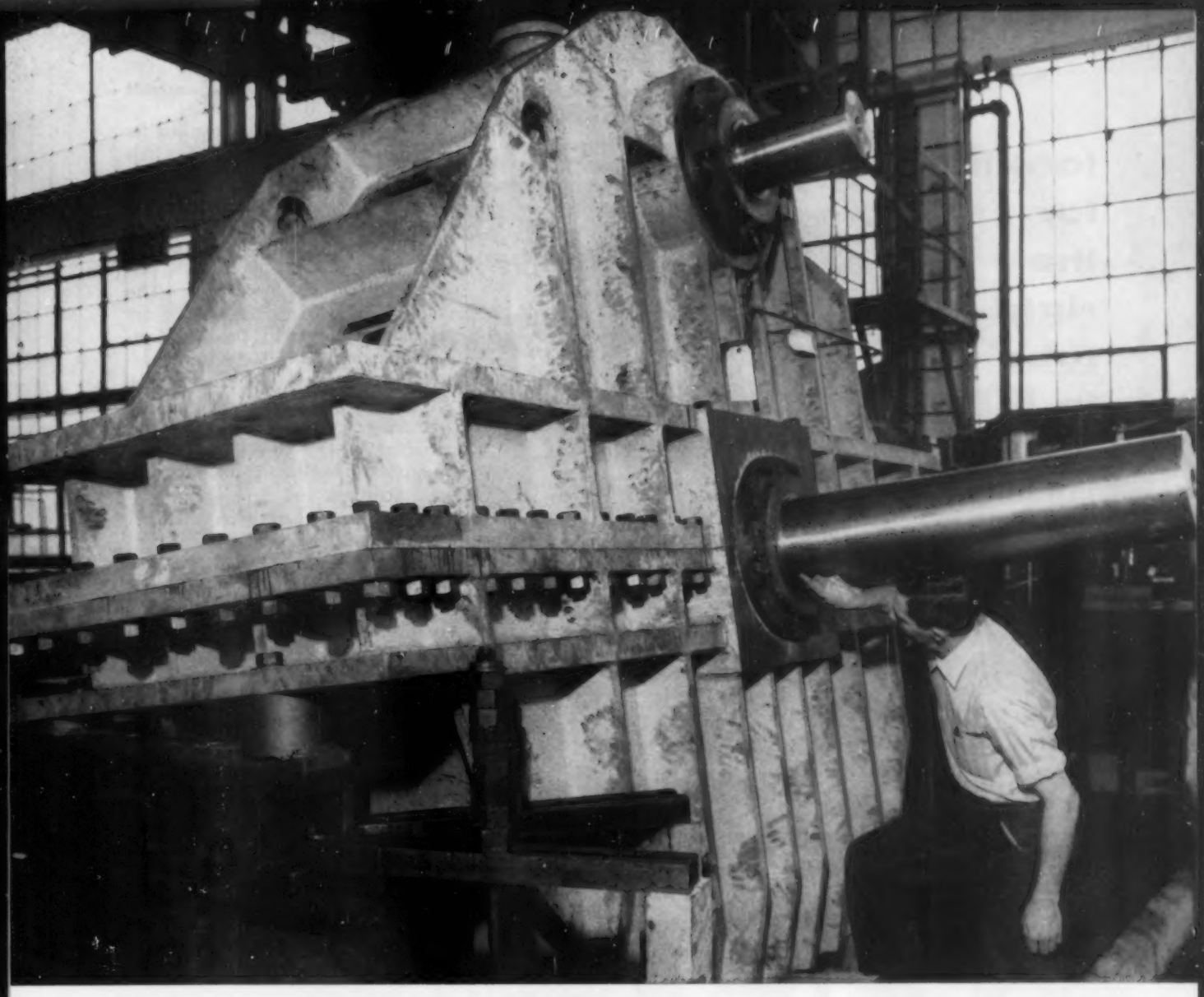
This book is not only a compilation of definitions of 1350 terms found in metallographic practice but an encyclopedic treatment as well. Included in this work are pertinent terms from the collateral sciences, such as micrography, macrography, radiography, mechanical and magnetic testing, chemistry, physics and physical chemistry.

The terms are defined in detail thus making this volume an excellent reference book for the metallurgist and engineer. It is hoped that this work can be expanded in the future to include new terms as they come into general use. Perhaps a book of this kind should not be bound so that revisions could be made by loose-leaf or any other system of insertions.

Titanium in Industry

STANLEY ABKOWITZ, *Materials Engineer, Alloy Development Section, John J. Burke, Chief Phase Transformation Section and* RALPH H. HILTZ, JR., *Metallurgist, Metallographic Section, Watertown Arsenal Lab. 6 x 9¼ in., 224 pp. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y.* $5.

Titanium production has grown from 2 tons in 1947 to 5,000 tons in 1954 with additional capacity under construction in 1955. It is estimated that titanium sponge capacity will total 35,000 tons by 1956. Re-



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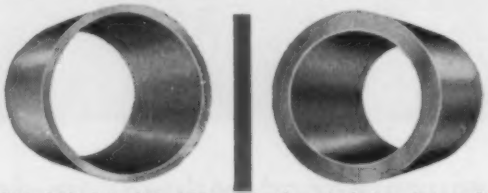

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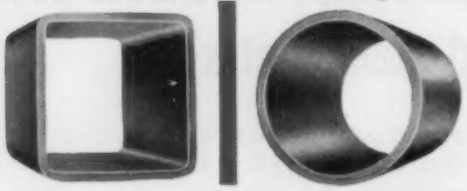

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search and development programs for the production and fabrication of this new light metal are going forward at a vigorous pace.

This book, therefore, is timely in that it presents, between two covers, a number of the fundamentals pertinent to the titanium industry. The subjects included in this volume are production, properties and fabricating processes. There are chapters describing alloying, heat treatment, hot and cold shaping, casting and powder metallurgy, joining, machining and grinding.

Surface properties, corrosion resistance, coatings and cleaning are discussed and a chapter on chemical analysis and metallography is included. Bibliographies are given at the end of most chapters providing interested readers with additional reference material.

This reviewer concurs with the stated dedication that Col. Benjamin S. Mesick is the man whose efforts have played such a valuable role in the advancement of titanium and is happy to see this acknowledgment.

Titanium in Iron and Steel

GEORGE F. COMSTOCK, *Consultant and formerly Assistant Director of Research, Titanium Alloy Mfg. Div., National Lead Co. 6 x 9¼ in., 294 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $6.*

The book is the third in the new series of monographs on alloys of iron. More than 280 technical papers are reviewed and listed in a chronological bibliography. Opening with a general discussion of titanium and its minerals, the book goes on to describe the extractive processes for titanium and the properties and effects of the element as an addition to cast iron and steel.

The deoxidizing effects are discussed and emphasis is placed on its unique effects in stabilizing nitrogen and in fixing carbon in alloys where other carbides may be undesirable. The book includes data on the usefulness of titanium in steel which is to be enameled and in certain complex ferrous alloys for high-temperature applications.

The monograph includes "Titanium in Steel" which was written by

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News about

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Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New Crack-Free Chromium Plate gives superior protection

Structurally perfect finish from stress-free chromium

Differences in the structure of ordinary chromium and Crack-Free Chromium deposits are shown by the photomicrographs below.

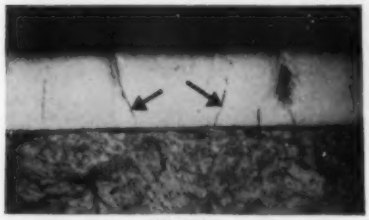

Fig. 1

Fig. 2

Figure 1 shows a cross section of etched ordinary chromium .00125" thick, with part of its network of cracks. Note that some cracks extend through the deposit to the base metal, providing an unimpeded path for corrosives.

Figure 2 shows a section of etched Crack-Free Chromium also .00125" thick. Note the complete absence of cracks.

• • •

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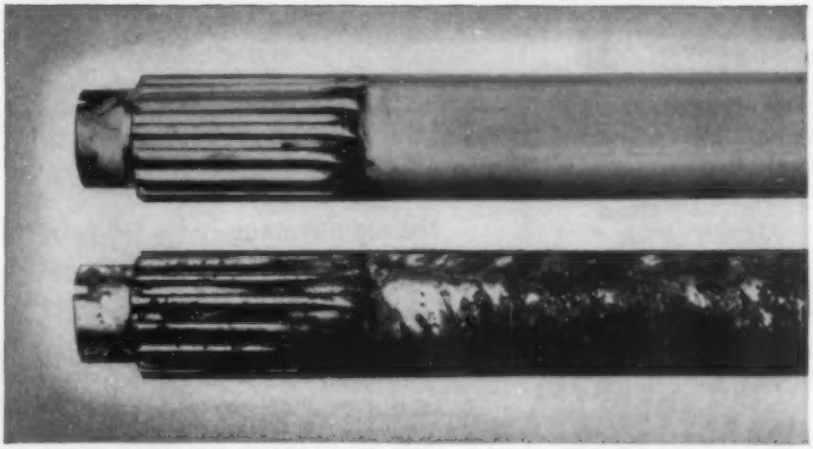


Upper steel shaft, with 0.0005 inch of Crack-Free Chromium, was virtually unaffected after 100-hour salt spray test. Surface of lower shaft with 0.0005 inch of ordinary chromium was completely covered with rust.

A basic need has at last been satisfied. A chromium deposit which gives better protection against corrosion is now obtainable by means of a new process developed by United Chromium.

Unichrome Crack-Free Chromium Plating produces more ductile deposits which are relatively free from internal stress. Thus, deposits do not crack as they are built up to hard plating thicknesses. In this respect they are unlike ordinary chromium which develops cracks, providing corrosives with paths to the underlying metal.

EFFECTIVE PROTECTION DIRECTLY ON STEEL

The photograph above shows that .0005" of Crack-Free Chromium plated directly on the steel prevented rusting of shafts subjected to 100 hours of salt spray, while the same thickness of ordinary chromium failed completely.

In other corrosion tests, parts plated with .0003" of Crack-Free Chromium were as good as new after a full year at 100% relative humidity and 110°F whereas parts with ordinary chromium were entirely covered with rust in days.

For many decorative applications, Unichrome Crack-Free Chromium can be plated directly on steel or zinc base die castings, eliminating need for scarce nickel.

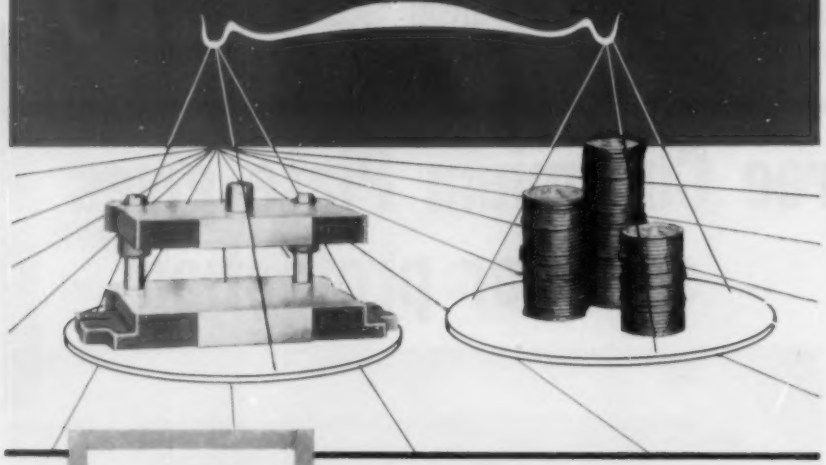
OTHER BENEFICIAL PROPERTIES

Crack-Free Chromium deposits are hard (500 to 700 Knoop), have a low coefficient of friction, and a non-galling, non-seizing surface. The plate has superior ductility and resistance to thermal shock. Unusual leveling action is provided by the solution.

Its grayish, matte finish needs buffing for high luster, but this is done as readily as buffing dull nickel. Attractive two-tone effects can be produced by buffing some areas, leaving others as plated.

Unichrome Crack-Free Chromium has already proved its advantages for hard chromium plating and certain decorative applications in successful commercial operations. Bulletin CFC-1 gives more details. Send for your copy.

YOU GET *full value* IN DETROIT DIE SETS



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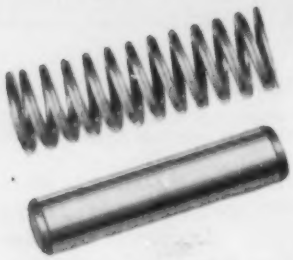
The big advantage of a *full-value* Detroit Die Set is that you get what you specify... factory-tested to assure you exact thickness of die holder and punch holder, true parallelism and squareness of surfaces, precision fit of pins and bushings. This means not only the accurate die set you expect, but also faster mounting, less maintenance, longer life. Reworking a die set in your shop can cost many times the difference between a "bargain" die set and a *full-value* Detroit Die Set.



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the author in collaboration with S. F. Urban and Morris Cohen. This was published by Pitman Publishing Corp. in 1949, and privately distributed. Consequently, this book is a more important work since it is more comprehensive and up-to-date.

One of the observations made in the book is that small amounts of titanium have a grain-refining effect on cast steels but must be used carefully as a deoxidizer to avoid the critical degree of deoxidation which results in the type of sulphide inclusions that cause low ductility.

Titanium, like other deoxidizers, tends to promote graphitization in cast iron. It also produces fine titanium carbide crystals in molten iron before it solidifies, and these promote fine grain size by a nucleating effect. In general, machinability and resistance to heat, corrosion, and wear are all slightly improved by titanium in cast iron.

This book is a complete treatise on the subject and provides engineers, metallurgists, and laboratory personnel with information on the element. It is recommended as a reference book by this reviewer.

Protective Coatings for Metals

R. M. Burns, *formerly Director of Chemical and Metallurgical Research, Bell Telephone Laboratories, Inc., and* W. W. Bradley, *Technical Staff, Bell Telephone Laboratories, Inc.* 6 x 9¼ *in., 643 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.* $12.

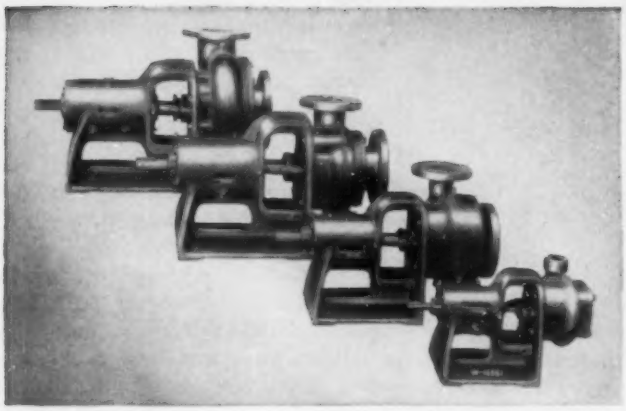
This book is the second edition of a monograph which first appeared in 1940. The current work is greatly enlarged over its predecessor since it includes the significant developments effecting the use of metals during World War II and the subsequent industrial expansion period that followed.

The book includes sections on the evaluation of organic coatings, corrosion inhibitors, chemical conversion coatings and sprayed metal coatings. Such troublesome phenomena as "silver migration" and "metallic whiskers" are explained as well as the latest practices in metal cleaning, coating application and testing.

The volume has been designed

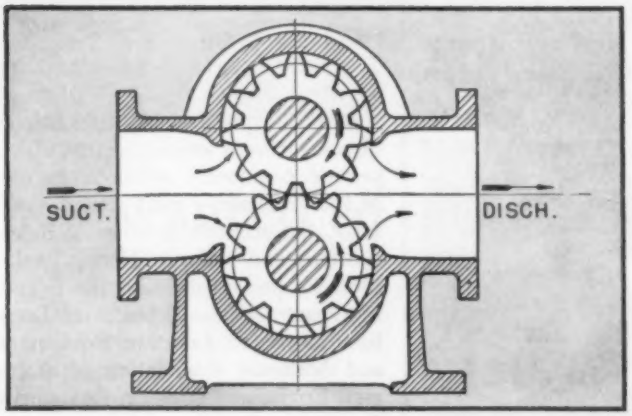
WHAT'S YOUR P.Q.*?

* Pump Quotient



Why are more and more end-suction pumps being specified? The answer's *simplification.* Industry is turning to end-suction pumps because they simplify piping (especially in process applications), need only one stuffing box, and make parts replacement easy. Get the full story on the Worthington end-suction pumps by writing to Section PC.4.8.

What is Worthite? Worthite is Worthington's "super-stainless", corrosion-resisting alloy steel containing more than 50% of the alloying elements: nickle, chromium, molybdenum, silicon, copper and manganese. The balance is mainly iron. Worthite was first introduced in 1936 and has gained wide acceptance as an excellent construction material for applications where corrosion is a problem. Worthington, of course, offers a complete line of Worthite pumps. Write for Bulletin W-350-B4.



Why are gear-type rotary pumps best for handling high-viscosity fluids? Lots of reasons. First, their large, unobstructed passages mean low entrance losses. Then, there aren't any valves or valve springs. Also, there's the flexibility in application offered by the wide speed range of gear-type rotaries. Write for Bulletin W-483-B2 for facts about the Worthington double-herringbone gear rotary pumps and vane pumps. PC.4.10

Write today for bulletins on end-suction pumps, Worthite and gear-type rotary pumps. Worthington Corporation, Merchandising Division, Section PC.4.10, Harrison, New Jersey.

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Trenton, New Jersey

primarily for those who have problems of protection. It is not intended to be a manual for the production of protective coatings although information on this phase is included in the book. The chapter on corrosion inhibitors is of special significance because the retardation of the rate of corrosion cell reactions by the use of inhibitors is growing in engineering importance.

The authors, who are members of the research staff of the Bell Telephone Laboratories, Inc., are well qualified to write a book on this subject. Their work is a comprehensive volume which is well-illustrated. They have included a bibliography in each chapter which gives the reader a fairly complete source of material in the event that he wishes to cover a specific section more thoroughly. The book is an excellent reference work on protective coatings for metals and should prove useful to corrosion engineers, metallurgists and chemists.

Holes, Contours and Surfaces

RICHARD F. MOORE *and* FREDERICK C. VICTORY. 7½ x 10½ *in.*, 424 *pp. Published by the Moore Special Tool Co., Inc., 748 Union Ave., Bridgeport 7, Conn.* $7.50, *(within metalworking industry—*$5.00).

It is the purpose of this book to discuss methods and equipment which provide engineered solutions to one of the toolmaker's most serious problems: the accurate location of holes, contours and surfaces. Detailed solutions are presented under the following chapter titles: Problem of Location; Improved Location Equipment and Methods; Foundation of Accuracy; Engineered Location Equipment Standards; Coordinate Locating System; Jig Boring Principles and Applications; Jig Boring Practices; Jig Grinding Principles and Applications; Jig Grinding Holes; Jig Grinding Contours; Linear Form Grinding Principles and Applications; Linear Form Grinding Practices; Inspection Methods; Precision Pays Dividends. Typical workpieces are used to illustrate the principles and practices described.

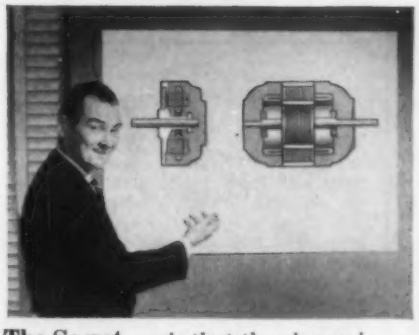
Also, 184 pages of Woodworth Hole Location Tables for converting hole locations in polar coordinates to rectangular coordinates are included.

They wanted to add another machine on the line

Fairbanks-Morse Design Engineers wanted to see how *you* could get more production out of every square foot of premium production line space.

They designed the now-famous Fairbanks-Morse Axial Air Gap Motor that is much shorter than conventional type motors. That saved "motor space" can become "production space" by the addition of one or more machines to every production line.

It is this kind of design approach that typifies the product bearing the Fairbanks-Morse Seal of Quality. When next you look for an electric motor . . . a scale . . . a pump . . . a diesel engine, look for the F-M Seal and see the difference that quality makes. Fairbanks, Morse & Co., Chicago 5, Ill.



The Secret . . . is that the air gap in this motor is perpendicular to the shaft, rather than parallel as in a conventional motor . . . without sacrifice in performance.

The Result . . . is that by replacing conventional motors with F-M Axial Air Gap Motors, enough space has been saved to add one or more machines to the line.

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OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Drafting "Research"

To the Editor:

Thank you very much for continuing the pros and cons on "Simplified Drafting."

Attempts to reduce drafting costs have centered mainly on simplifying the line work and introducing improved drafting tools. An objective appraisal of highly simplified line work reveals that the effort saved by one individual (the draftsman) is largely dissipated by the effort expended by the numerous readers of the prints made from the drawing, hence, no real saving is accomplished.

There is another region in the realm of drafting effort which is time consuming in most engineering departments. This effort is sometimes cynically referred to as "research." To illustrate the definition of this kind of research, let us consider Figs. 1 and 2 and the effort required to draw them.

Fig. 1 is a shaft on which two ball bearings are to be mounted, one held by a retaining ring and the other by a bearing locknut and washer. The fifteen dimensions indicated are two-thirds of the dimensions required to complete the drawing. To fill in the numbers necessitates the draftsman securing a bearing catalog, a retaining

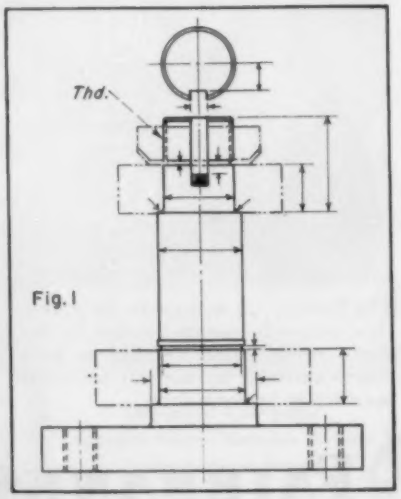

Fig. 1

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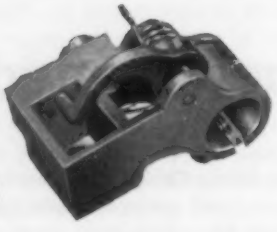

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When your specifications demand BRUSH HOLDERS with high wearing qualities, low maintenance cost — pick from our more than 1,000 types, or have our engineers design your special type. These special designs shown are three of many produced for specific applications. . . . . The 'something special' in BRUSH HOLDERS is produced by the specialist. Ask FLOWER

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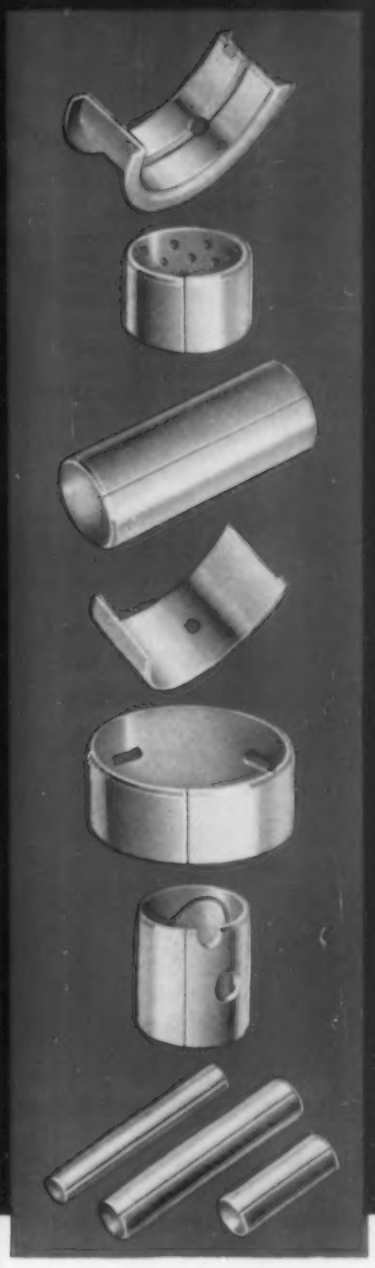

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Good weather and freedom from mechanical failure used to be the farmer's harvest prayer. Today, weather is his only gamble and even that is reduced by highly dependable, fast-working machines—operating around the clock if need be. An important contribution to this mechanical dependability comes from precision-made sleeve bearings and bushings. They protect the crankshaft, maintain internal lubrication, absorb piston thrust loads, endure extreme heat, dust and long hours of steady work. Quality in their manufacture shows up in dependable field operation. We are specialists in quality bearings and bushings for engine, transmission and chassis applications—and a major supplier to the farm tractor and implement-building industry. Federal-Mogul Corporation, Detroit 13, Michigan.

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The Viking pump line exceeds all others in the rotary pump field. This one fact alone means you can have a pump to really fit your needs . . . one that is efficient for your job.

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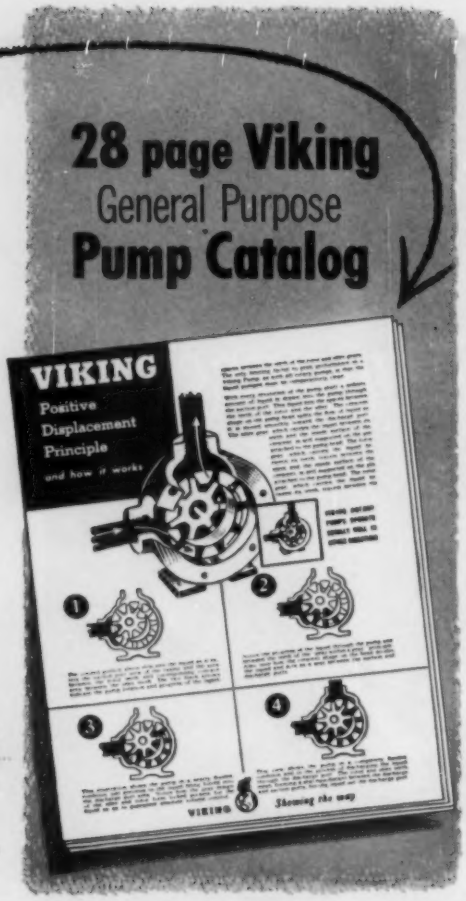

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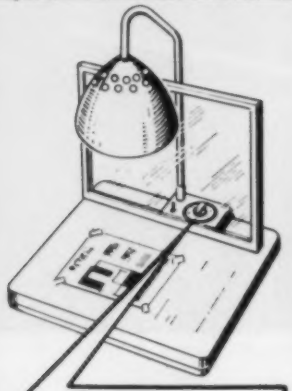

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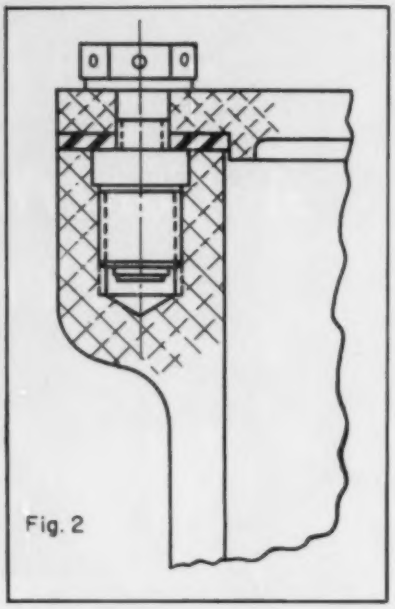


ring catalog and a consultation with an engineer or designer to determine the fits between shaft and bearings.

In the ideal situation, the catalogs and the engineer are readily available. In the average engineering department, however, a well kept, abundantly supplied catalog library is the exception rather than the rule. In fact, the writer has observed that sometimes the purchasing department must share its files with engineering. Time consumed in locating supervisory personnel is sometimes a problem also.

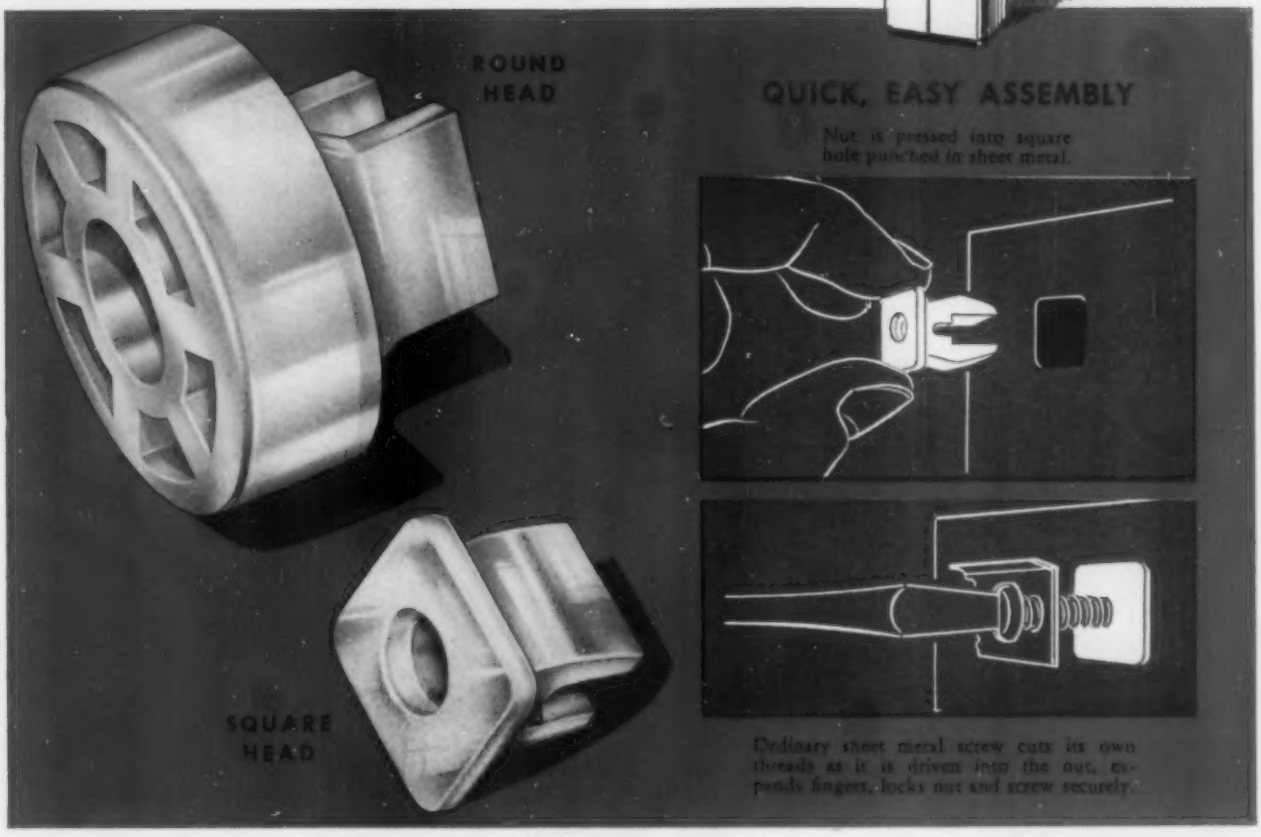
Fig. 1 exemplifies a simple case, but as the catalog item becomes more complex the time required to draw a mating part is often far less than the time spent in searching out the cataloged item. This time is not apparent when reading the detail drawing, and is, therefore, often overlooked in evaluating the cost of such a drawing.

Fig. 2, a portion of an assembly drawing, is shown as an example of the steps required to determine only one dimension, namely, the length of the bolt. The draftsman must know the thicknesses of the washer, cover and gasket, as well as the length of the thread insert, and the space available below it. In a critical application, the compression factor of the gasket would also require consideration. Once again, the accumulation of data, rather than the time to draw the part, is the major prime factor.

Here then, in the region of preparation to draw, lies an opportunity to save effort without sacrifices in draw-

How many ways can **you** use

DOT PLASTIC *snap in* NUTS?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QUICK, EASY ASSEMBLY
Nut is pressed into square hole punched in sheet metal.
Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely.

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

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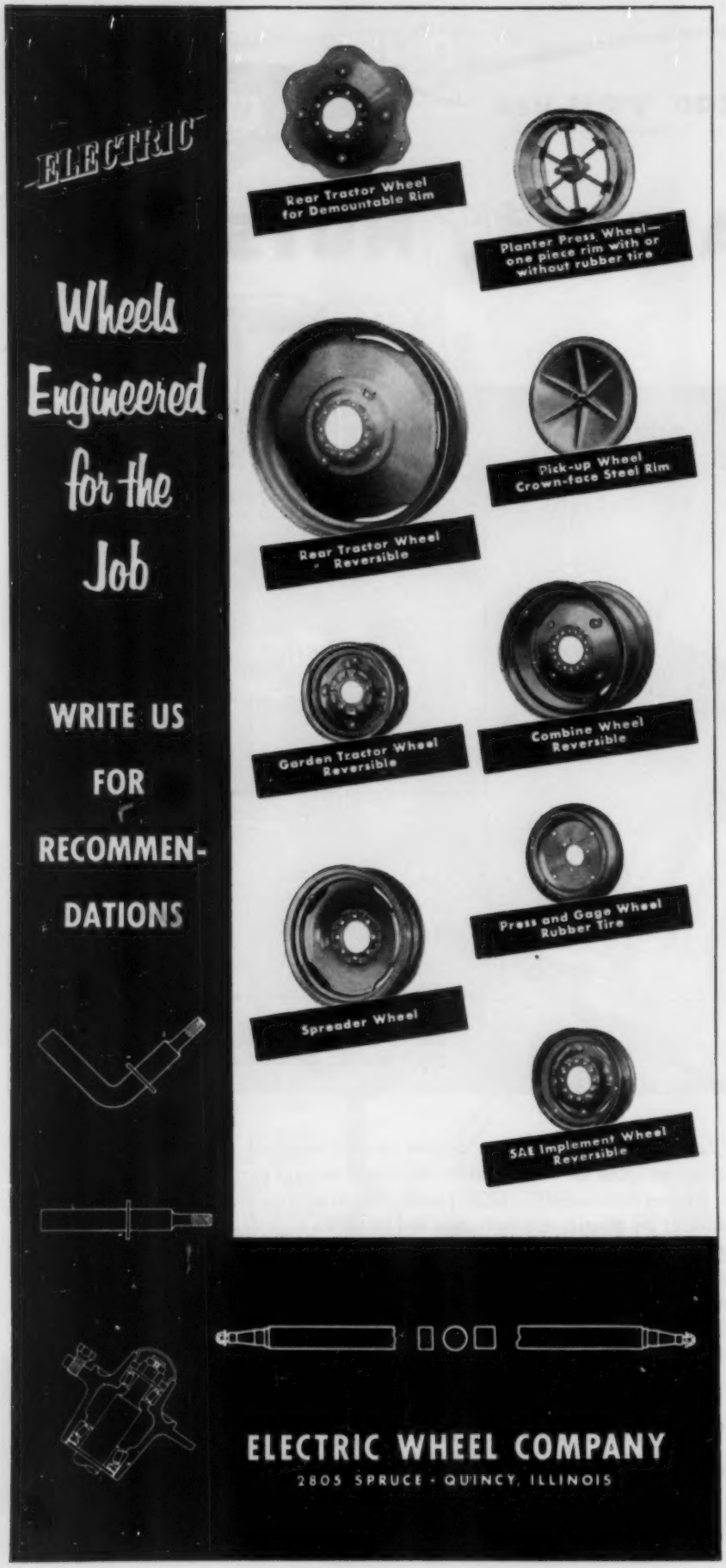
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ing quality. It is the conclusion of the writer that any development engineering department having more than fifty technical employees justifies a librarian of engineering graduate level, broadly familiar with commercial products and capable of understanding application problems in the early design stages. In small groups, the overhead salary costs can be eased by using a part-time librarian.

The thread symbols used in the figures are acceptable forms of simplified line work, and it is believed that limited use of further simplifications is in order. However, the savings from such practices are not likely to make startling accounting news.

—Marvin O. Young
All American Engineering Co.

Punched Card Equipment

To the Editor:

I am writing in reference to my article "Using Punched Card Equipment for Automatic Machine Tool Control," *Product Engineering*, June 1955. I was very pleased with the general layout and editorial revisions.

Two errors occurred in this article, both typographical in nature. The first error occurs on page 175, first column, in the large equation, center of page. It should read:

$$r_{\theta 2}=\frac{(\phi_1-\phi_2)(\theta_3-\theta_2)^2-(\phi_3-\phi_2)(\theta_1-\theta_2)^2}{(\theta_1-\theta_2)(\theta_3-\theta_2)^2-(\theta_3-\theta_2)(\theta_1-\theta_2)^2+}$$

$$(\phi_1-\phi_2)(\theta_3-\theta_2)^2-(\phi_3-\phi_2)(\theta_1-\theta_2)^2$$

The second error occurs in the sentence at the center of the left-hand column, page 176. This should read:

"The equation for the angle of movement of cutter, H_θ, is:

$$H_\theta = (L_3/rc) - t_\theta$$

where L_3 = arc length corrected for true center distance."

A third error, just below the last equation, first column, page 176, was in my original copy. It should read: "The calculations are programmed in 64 steps and require 30 digits of input and 10 constants, two of which are the radius of the cutter and the center distance of the gears of cutter, previously defined as equal to l, but now compensated to be true value."

—Alan H. Stillman
Sperry Rand Corp.

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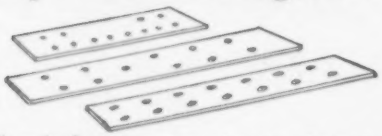
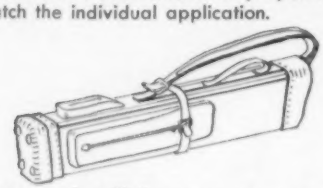
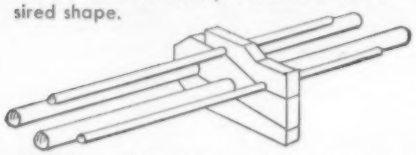
Tips for designers



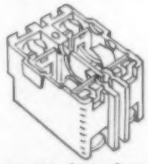
Terminal strips for aircraft electronic equipment Grade GEC epoxy laminate, and of Grade 353 and Grade C phenol laminate . . . each chosen for properties to match the individual application.



Bottom of golf bag is made of Taylor Vulcanized Fibre . . . a tough, abrasion resistant material readily formed to the desired shape.



Fuel line clamp for a fighter airplane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.

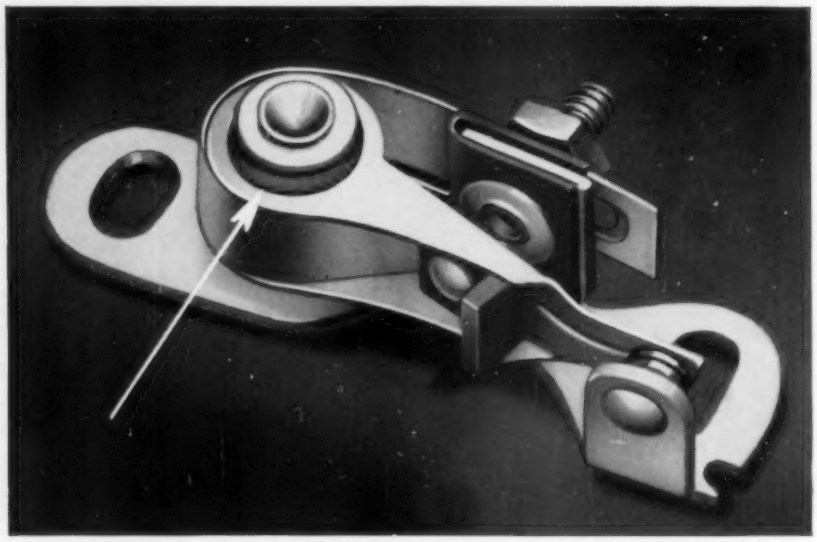


Liners for circuit breakers are made of Taylor Vulcanized Fibre, whose arc-resistant properties protect the breaker's molded base from the damaging effects of arcing at the breaker points.

Taylor Fabricating

FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Distributor breaker assembly uses Taylor XX laminated tubing for the contact arm bushing. This paper base laminate maintains high dielectric strength under humid conditions, has good dimensional stability and machines readily.

Design for performance and economy— *with Taylor Phenol Laminates*

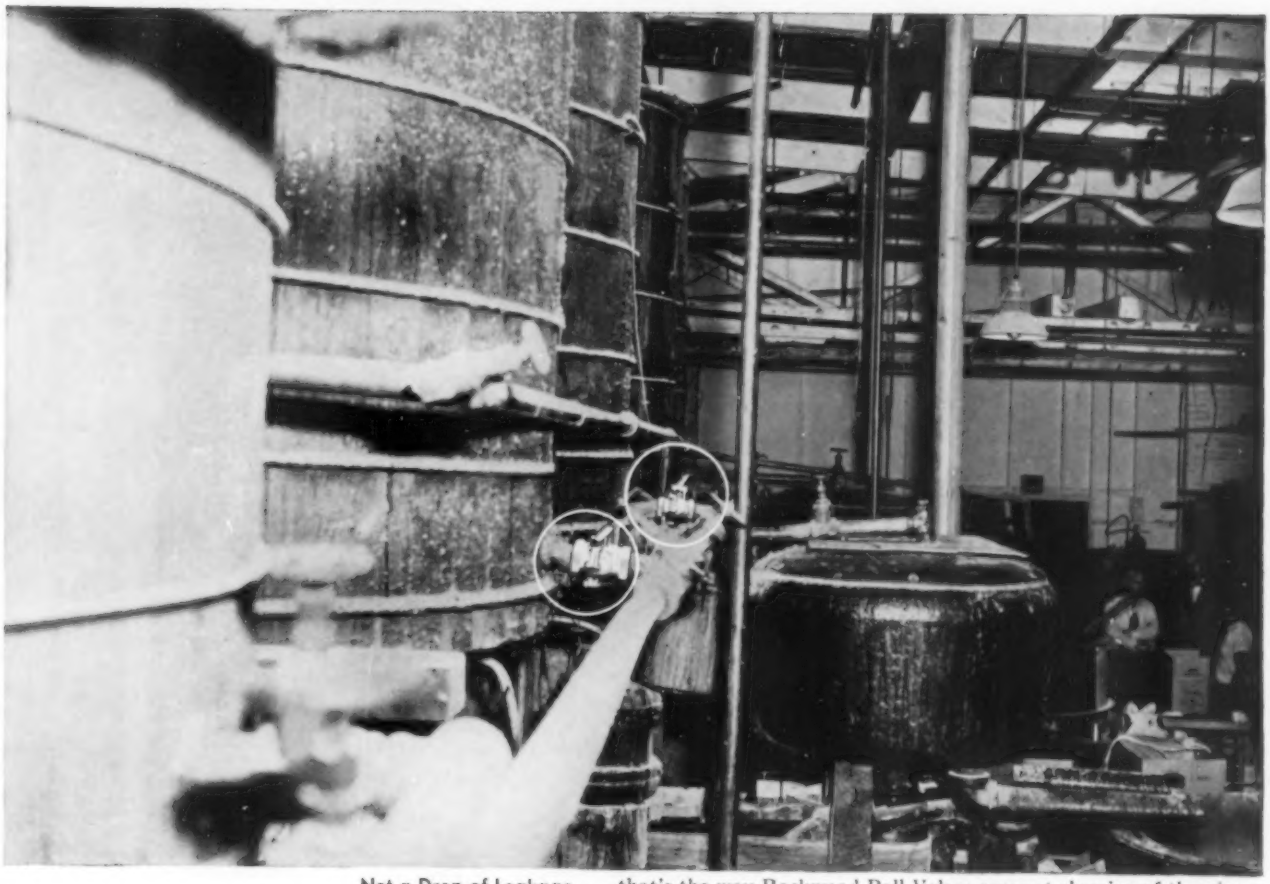
You can be sure of getting performance to fit your product at a price to fit your budget, when you design with Taylor phenol laminates. More than thirty different grades offer you a broad combination of electrical, physical and machining properties that cover a wide range of product applications.

Included in this selection of materials are paper and fabric base grades. Notable among these is a family of hot punch laminates—the new "300" series. Especially developed for the increasingly stringent demands of modern electronics, this series marks a new high in ease of fabrication and economy . . . plus exceptional stability under all climatic conditions.

You'll find that Taylor laminates can lead to real economies in production, through their excellent punching, staking and machining qualities. They come in forms that permit efficient production of varied shapes . . . sheets 49″ by 49″, tubes and rods. And they're a real bargain in performance, often giving you properties found only in premium-priced materials.

Equally important, you're always sure of quality. Taylor formulates its own resins . . . manufactures its own special grades of paper . . . all under the strictest laboratory control.

Write today for a copy of the general catalog on these and other Taylor materials. And ask a Taylor specialist to see you for a consultation on your specific materials selection problem.



Not a Drop of Leakage . . . that's the way Rockwood Ball Valves prevent clogging of the pipes attached to these shellac-cutting tanks.

No leaking, no maintenance

. . . no wonder — they're Rockwood Ball Valves!

Rockwood Ball Valves give you leakproof, trouble-free performance! The Parks Company of Fall River, Massachusetts, have had Rockwood Ball Valves on this line for 3 years without maintenance.

Rockwood Valves prevent dripping and clogging of the pipe line, keeping production at a steady uninterrupted pace. There has to be a good reason for this kind of outstanding performance — and there is!

In fact, there are four excellent and exclusive reasons why Rockwood Ball Valves can give you such dependable service —

Full Round Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss

Quick Opening and Closing — only a quarter turn needed

Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, pitting and scratching

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
804 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name . . . . . .

Title . . . . . .

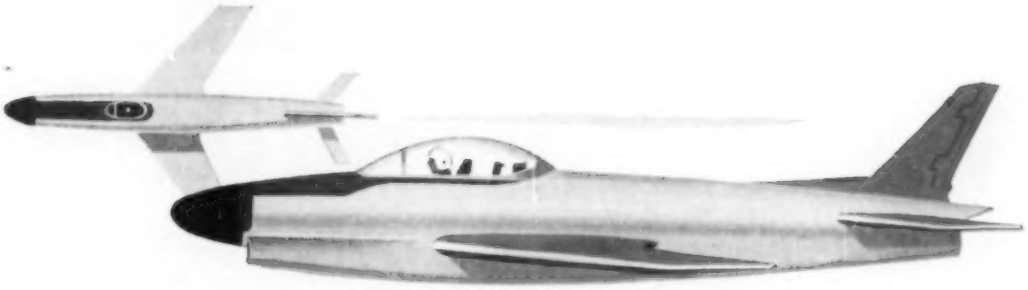
Company . . . . . .

City . . . . . .

Zone . . . . . *State* . . . . . .

Dinette settings by Lynn Scott, Director of the Plaskon Home Arts Council

You'll be sitting pretty too, when you specify fiber glass-reinforced PLASKON Polyester Resins. They present many unique opportunities to the imaginative engineer or designer. Reinforced PLASKON Polyesters offer higher strength-to-weight ratios than metals, great durability and dimensional stability. A variety of beautiful, unique finishes and almost unlimited range of color with varying degrees of translucency can be molded in to become an integral part of the finished product. The extraordinary properties of this material are revitalizing and improving products as diverse as lawn furniture and car bodies. Why not see for yourself how PLASKON Polyesters can help you add a new dimension to your designs? Write or call us today for complete information on any of our polyester formulations!



AIRCRAFT COMPONENTS. Tough, weather-resisting, reinforced PLASKON Polyester Resins are widely used in aircraft radomes and other aviation applications. Because the cure of these unique materials is not affected by the presence of air, PLASKON Polyester Resins are well suited for both air cure and press molding operations.

BOAT HULLS made from glass-reinforced PLASKON Polyester Resins are leaders in the booming "plastic boat" market. We have available integral resins especially designed for the lay-up of large units such as boat hulls. Unlike others, these resins offer toughness without sacrificing strength characteristics.

TRANSLUCENT SHEETING. Superior weather and erosion properties are characteristic of translucent sheets molded of PLASKON Polyester Resins. Molders working with our resins find *consistent* uniformity . . . enabling them to produce the same high-quality-controlled panels month after month.

For further information on PLASKON Plastics and Resins, address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y. Phone HAnover 2-7300.

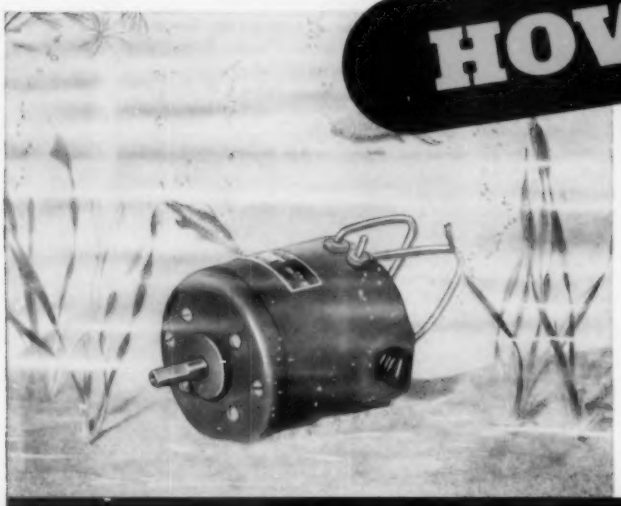
Allied Chemical

Barrett PLASKON

For extreme operating conditions

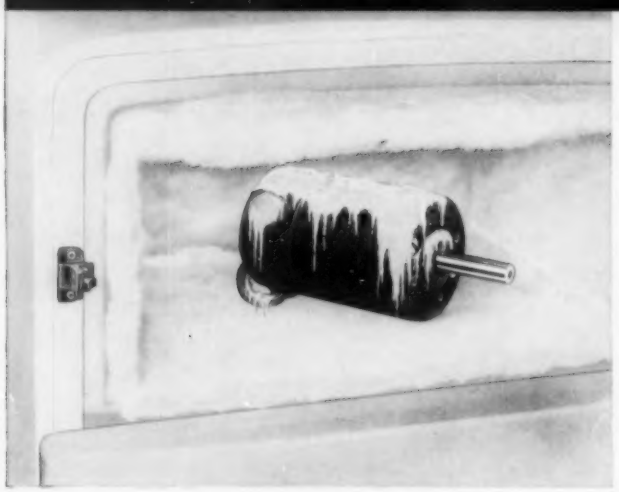
CHECK YOUR FRACTIONAL H. P. MOTOR APPLICATIONS WITH

HOWARD

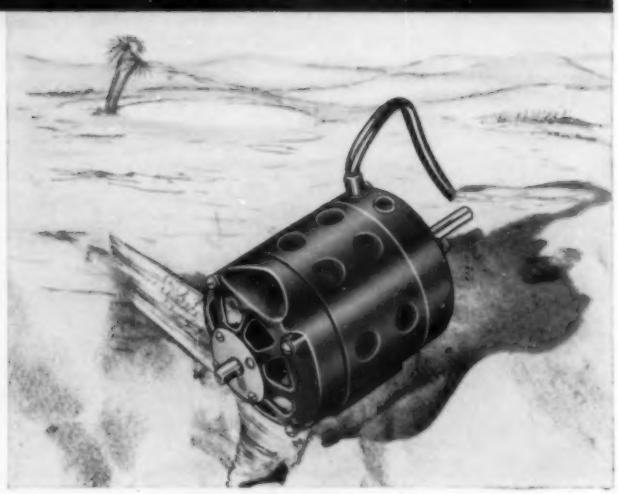


UNDER WATER

AT HIGH ALTITUDES



EXTREME COLD



EXTREME HEAT

Have a difficult fractional h.p. motor problem? Why not check with fractional h.p. motor specialists? Whether it be a problem of waterproofing, altitude, cold, heat, extreme quiet operation, long life or other exacting conditions, Howard has the motor to fill your need.

You'll find that Howard makes the most complete line of **fractional h.p. motors in the entire industry—Universal, Direct Current, Shaded Pole, Induction and Servo Motor types as well as gear motors and blowers in ratings from 1/2000 to 1/2 h.p.**

If you use fractional h.p. motors in your products, be sure to check with Howard. Write, wire or phone Racine 2-2731.

Make sure you Own the United States Defense Bonds

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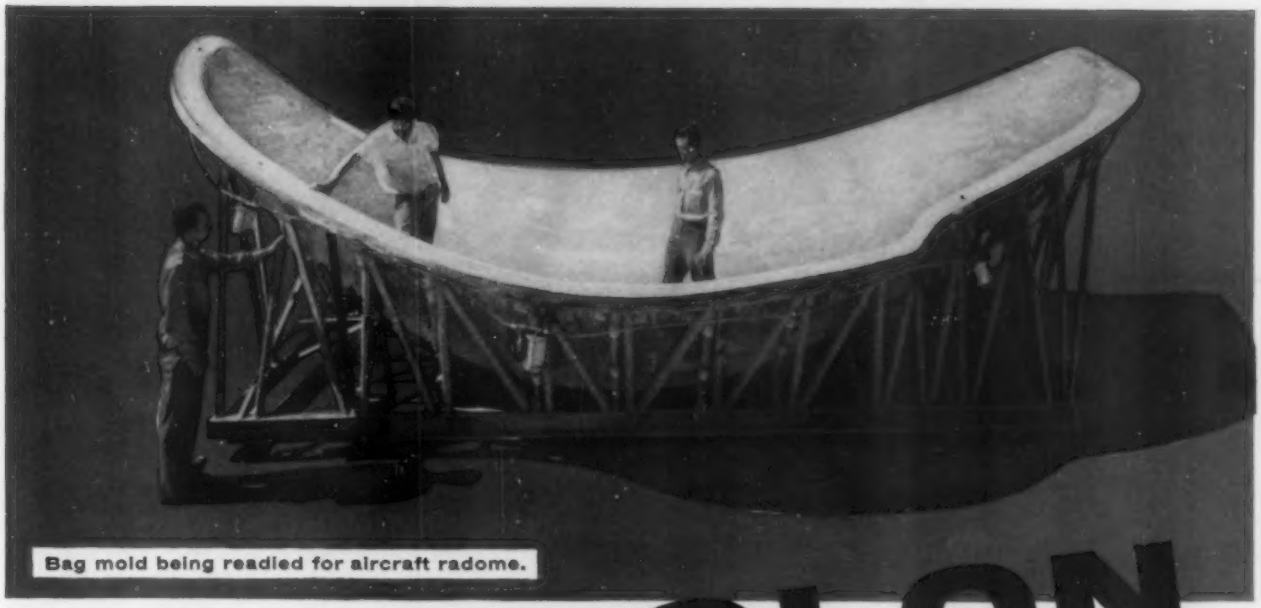
Small Part or Large... Produce Them Faster and at Lower Cost with



Bag mold being readied for aircraft radome.

REYNOLON

polyvinyl alcohol

Completed aircraft radome.

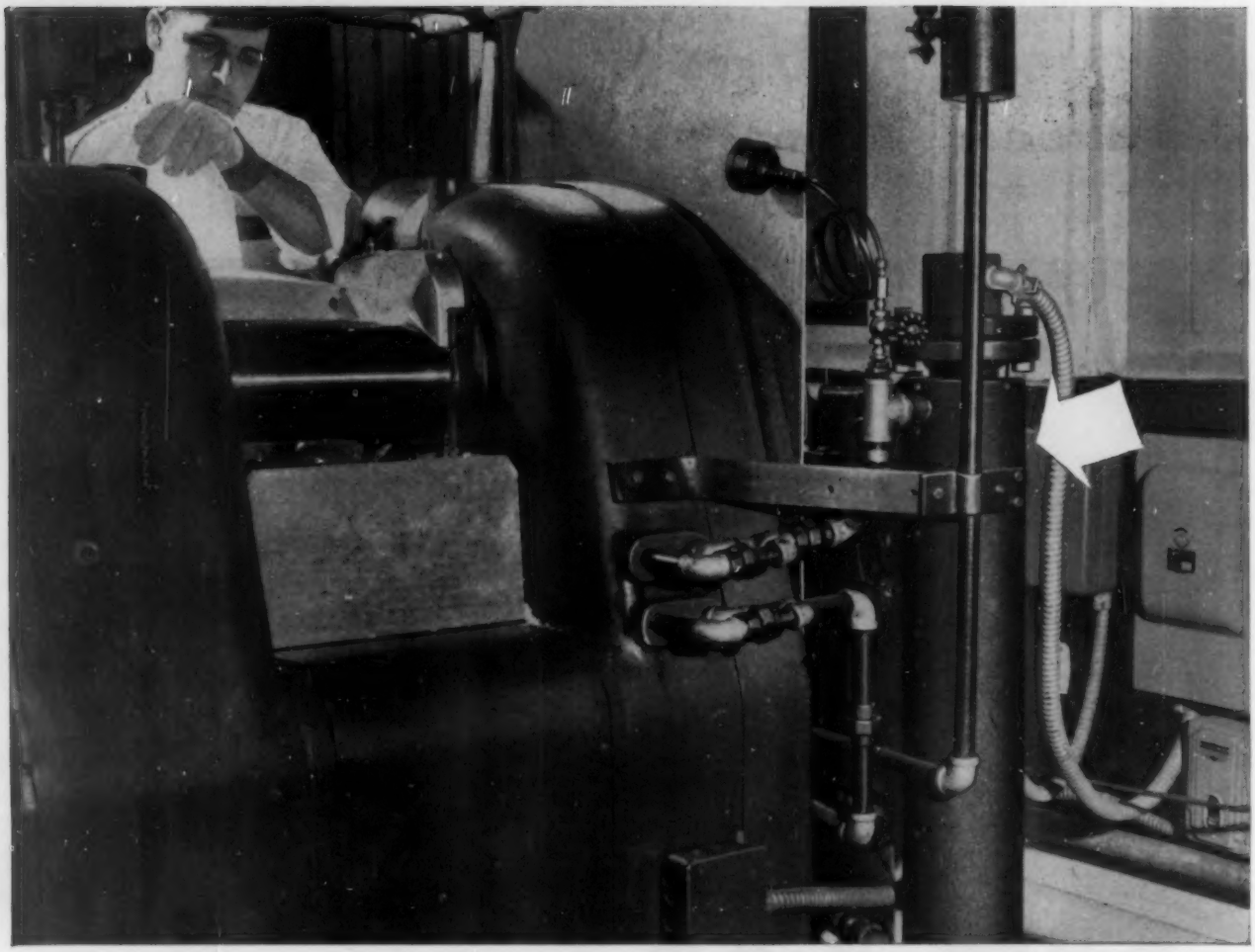
From the reinforced plastic pipe section to the aircraft radome above, bag molding with Reynolon Polyvinyl Alcohol Film offers definite advantages to design and production men in diversified industries. Plastic bag molds can be made faster than matched metal dies thus you can get into production quicker. Bag molds also are less costly than matched dies. And—the high elongation features of Reynolon Polyvinyl Alcohol Film as well as its non-inhibiting and clean separating qualities make it ideal for use in molding reinforced plastics. Design freedom is still another important "plus" for bag molding with Reynolon Polyvinyl Alcohol Film.

Highest quality, clear, strong Reynolon Polyvinyl Alcohol, Polyvinyl Chloride, Polyethylene and laminates of Polyethylene and Cellophane are all available in many standard specifications or can be economically produced for your specialized requirements. Our Technical Product Development Service is also available to you without obligation.

Photos courtesy of:
Zenith Aircraft
Division of Zenith Plastics Co
Gardena, Calif.

For complete information,
contact your nearest Reynolds Metals Company office or write

PLASTICS DIVISION,
REYNOLDS METALS COMPANY
3802 GEORGIA STREET • GARY, INDIANA



electrically heated oil eliminates high-pressure steam ...improves performance of plastic blending mill

To heat a plastic blending mill to temperatures ranging from 200 to 450°F was the problem faced by this manufacturer of extruded plastic films.

A steam system did not prove entirely adequate. For in order to supply the higher temperatures, it required high pressures. This put considerable strain on the expensive blending machine and other parts of the system. Losses in production time and material occurred while "waiting for pressure" during temperature changes.

Attaching a Chromalox Electric Oil Circulation Heater to the blending machine solved the problem . . . for electric heat generates high temperatures without high pressures. Heater inlet and outlet are attached directly to the steam lines. An oil circulating pump forces hot oil through the mill rolls. Installed capacity is 15,000 watts. Built-in automatic control measures out exact degree of heat to provide wide range of temperatures needed for fast, accurate blending.

Results are improved blending quality. Substantial increase in production. Considerable savings in raw materials. Reduction in maintenance.

This problem-solution-result approach has enabled us to help many manufacturers produce better, faster, at lower cost.

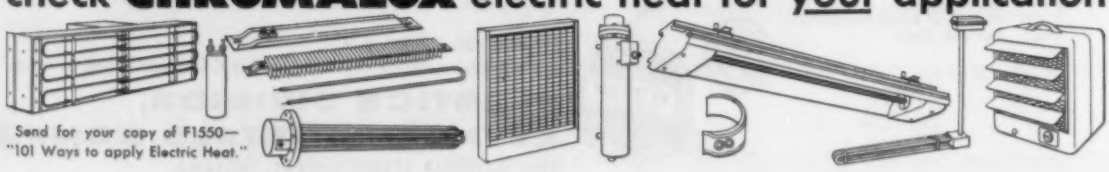
Always available to you are our research, engineering, design and modern manufacturing facilities. The world's largest factory stock of industrial electric heaters plus local stocks at strategic points. And a 33-city nationwide sales-engineering service.

Let us know your problem for controlled heat and we'll go all out to help you find the right answer—electrically.

A-4437

EDWIN L. WIEGAND COMPANY
7535 Thomas Boulevard, Pittsburgh 8, Pa.

check CHROMALOX electric heat for your application



Send for your copy of F1550—"101 Ways to apply Electric Heat."

ROLL FORMED SHAPES

Here's what Roll Formed shapes mean to you in terms of production and economy. As a designer or production man you know how saving an operation lowers unit cost. Continuous rolling, forming, notching and cutting to length saves man-hours, time and money . . . eliminates extra handling and assures you of uniformity and accuracy of product. Equipment in our modern plant can turn out your rolled or formed parts from ferrous or non-ferrous metals by the thousands . . . yes . . . hundreds of thousands of sections if required, and on a good delivery schedule. Let Roll Formed Products Company work with you on your next requirement. Send us blueprints or parts for prompt quotation. We would like you to know more about us. Our story is well told in our new catalog No. 1053. It shows you just what we do and how we do it. Write Roll Formed Products Company, Youngstown, Ohio.

ROLL FORMED PRODUCTS
COMPANY

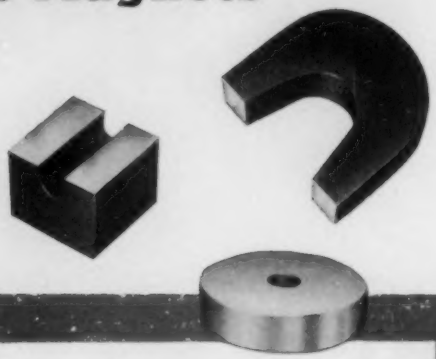
MAIN OFFICE AND PLANT
3756 OAKWOOD AVENUE YOUNGSTOWN, OHIO

a message

to Original Equipment Manufacturers Who Use Permanent Magnets

May we have 1 minute and 2 seconds to tell you why Indiana Steel Products Company can do the best job, and the most thorough job, of supplying your permanent magnet requirements?

HERE ARE 5 REASONS:



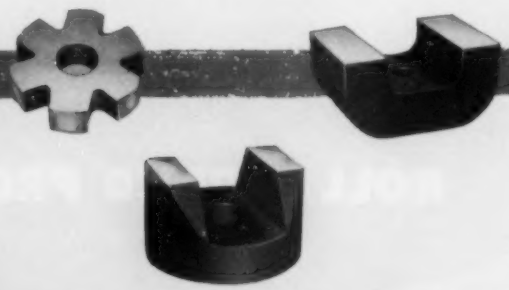
FIRST . . . we're specialists. Indiana Steel Products Company has concentrated on manufacturing permanent magnets for more than 45 years! Attention and interest are not spread over many different and unrelated products.

SECOND . . . all Indiana salesmen are trained *engineers*. In many cases, they can give on-the-spot assistance with immediate problems . . . no delay while they check with the home office.

THIRD . . . Indiana sales engineers draw on our company's 45 years' experience in designing and producing permanent magnets for every conceivable type of application. More often than not, he has *already* encountered problems similar to yours.

FOURTH . . . competently staffed local offices, with direct communication with the home office, assure you of the best possible service . . . expedite rush and emergency deliveries, when necessary.

FIFTH . . . Indiana salesmen are backed by the World's largest engineering staff devoted solely to the design and application of permanent magnets . . . and the World's largest and most complete magnetic research and production facilities.



DO YOU ANTICIPATE a need for magnets in your experimental work, or for use around the plant? Catalog #11-C9 lists a wide assortment. Drop us a line . . . we'd like to send you a copy.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

World's Largest Manufacturer of Permanent Magnets

VALPARAISO, INDIANA

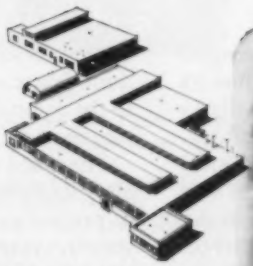
ANNOUNCEMENT!

Teer-Wickwire, manufacturer of precision parts, takes over Lindberg cylinder line

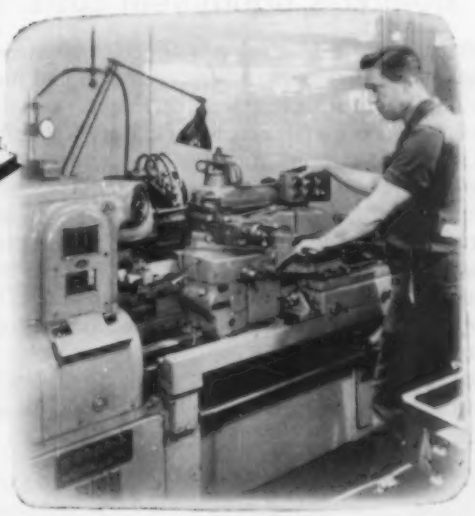
Now Lindberg Air and Hydraulic Division of Lindberg Engineering is Lindberg Air and Hydraulic Division of Teer-Wickwire & Co. Operations have been moved from Chicago to Jackson, Michigan, into a new plant devoted to cylinder manufacture.

Out of this modern 60,000 square foot plant at Jackson will come the present line of Lindberg air and hydraulic cylinders, manufactured to new standards of quality, durability and performance. In development now, and due for release soon, are revolutionary new cylinders to meet tomorrow's requirements with less bulk, less weight, less cost.

WHO IS TEER-WICKWIRE & CO.?



We are specialists in mass production of precision parts and components at low cost. We have been a contract manufacturer for the automotive industry for 25 years. We are *exclusive* suppliers of several components for some of the largest makers. Our plants are tooled with the latest machines. We combine proven production methods with rigid quality control systems to achieve high quality at competitive costs. *All of this experience now goes to work for users of air and hydraulic cylinders!*



The Monarch Tracer-type lathe pictured is typical of the modern machine tools used in our plant.

LINDBERG AIR AND HYDRAULIC DIVISION
TEER-WICKWIRE & COMPANY
Jackson, Michigan

WHAT—*HANDLES LIKE CARBON STEEL?*

That's right. Worked with the same techniques as carbon steel, Lukens "T-1" steel cuts equipment costs, reduces field fabrication headaches.

Although Lukens "T-1" steel is a tough, high strength, heat treated steel, designers and engineers will find that its ready weldability and excellent wear characteristics will pay off in design freedom and increased equipment efficiency. Because this low carbon, quenched and tempered steel poses no unusual problems in welding, equipment can easily be fabricated, modified or repaired not only in the shop but also in the field. Three times stronger than carbon steel, this new steel has lighter weight and reduced thickness in comparison to heavier, thicker plates of carbon steel, thereby reducing material, construction and shipping costs.

Lukens' range of steel plate sizes—including the widest and heaviest plates available anywhere—makes possible additional savings through the use of wider plates that require fewer welded seams. Lukens "T-1" steel's resistance to the combination of wear and impact abuse lowers maintenance and replacement costs, lengthens equipment life.

The latest addition to Lukens' complete line of carbon, alloy and clad steels, this new steel's unusual combination of properties suit it especially to applications in pressure vessels, bridges, shipbuilding, construction machinery and general industrial equipment. On problems of design, material selection, application and fabrication techniques, Lukens offers full technical assistance. If you would like further information on Lukens "T-1" steel, write for Bulletin 775. Address: Manager, Marketing Service, 775 Lukens Building, Lukens Steel Company, Coatesville, Pa.

LUKENS

"T-1" STEEL

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS

LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

Here's the Relay for today's high speed devices

Highly Sensitive
No Contact Bounce
Billions of Operations

THE CLARE TYPE T
High Frequency
Impulse relay

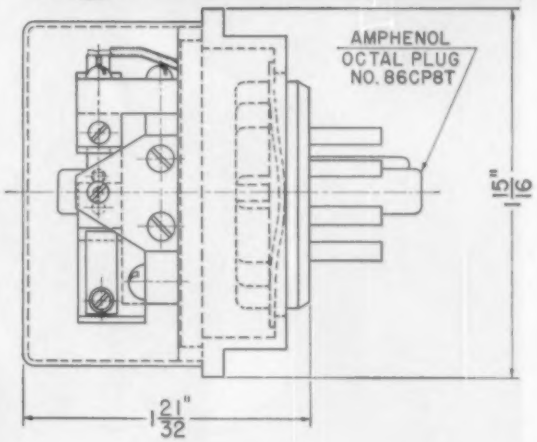
• Shown above with dust-tight cover removed (left) ready for mounting.

• Announcement of the CLARE Type T High Frequency Relay two years ago set off such a deluge of inquiries for samples and information that it is only just now that production facilities permit us to mention it again.

Originally designed for use in an analog computer, this relay is ideal for designs which call for a highly sensitive relay completely free from contact bounce and capable of billions of operations at extremely high speeds.

Pull-in time of this relay, for instance, is 120 microseconds. With dropout time of 100 microseconds, the relay follows up to 2500 cycles per second; aperiodic to 1000 cycles per second.

Manufacture of the CLARE Type T Relay, with its high speed, no bounce and other unusual characteristics, necessitated the development of entirely new techniques. It is built to extremely close tolerances, with a high degree of precision and fabricated under conditions of utmost cleanliness.



SPECIFICATIONS

MECHANICAL

Size: 1-15/16 in. dia. x 2-3/16 in. overall. Weight: 5 oz.

Mounting: Equipped with plug, to fit standard 8-pin octal socket.

Cover: Removable dust-tight cover.

Contacts:
- **Type:** Form A (s.p.s.t., normally open)
- **Material:** Platinum-iridium
- **Gap:** 0.0005 inch
- **Pressure:** 30 grams, min. (Coil energized with 50 ampere-turns)

Coil:
- **Type:** Single winding, bobbin-wound.
- **Wire:** Heavy formex.

ELECTRICAL

Operate Ampere-Turns: 8 to 20.

Release Ampere-Turns: 1 to 4 less than operate ampere-turns.

Nominal Ampere-Turns for High-Speed Operation: 16 to 40.

Speed of Operation: will follow 2500 cycles per second; aperiodic to 1000 cycles per second.

Operate Time: 100 to 180 microseconds.

Release Time: 60 to 120 microseconds.

Contact Bounce: None.

Contact Current Rating: 0.05 amp., max.

Contact Voltage Rating: 150 V., max.

Dielectric Strength: 500 V., rms.

Coil Resistance: up to 600 ohms.

Life Expectancy: 5 x 10^9 operations (determined by contact load).

TYPICAL CHARACTERISTICS

Coil Resistance: 135 ohms.

Coil Inductance: .35 Hy.

Operate Current: 10 to 12 ma.

Release Current: 8 to 10 ma.

Nominal Current: 40 ma., steady state; 20 ma., average.

Operate Time: 130 microseconds.

Release Time: 100 microseconds.

Energizing Circuit: Coil in plate circuit of vacuum tube with 300 volt plate supply.

For full information on the CLARE Type T Relay —or for consultation on any relay problem—see your nearest CLARE Sales Engineer or write C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Send for Clare Bulletin Number 117

FIRST IN THE INDUSTRIAL FIELD →

CLARE RELAYS

EXON: each resin engineered for a specific problem

EXON 654

specifically for

Plastisols

No grinding needed when you use Firestone plastisol resin. An extremely fine powder with high molecular weight, EXON 654 readily disperses in plasticizer with simple stirring equipment.

EXON 654 is expressly created to impart excellent heat and light stability, physical toughness and chemical stability to your products.

Pastes formulated from EXON 654 show exceptional viscosity stability and flow properties. Unsurpassed for processing ease and efficacy in coating fabric and paper, they endow these products with unusual tear and wear resistance.

Whatever your particular problem, you're likely to find the specific remedy in one of the many EXON resins.

Firestone

EXON

For complete information or technical service on the entire line of EXON *resins, call or write today.*

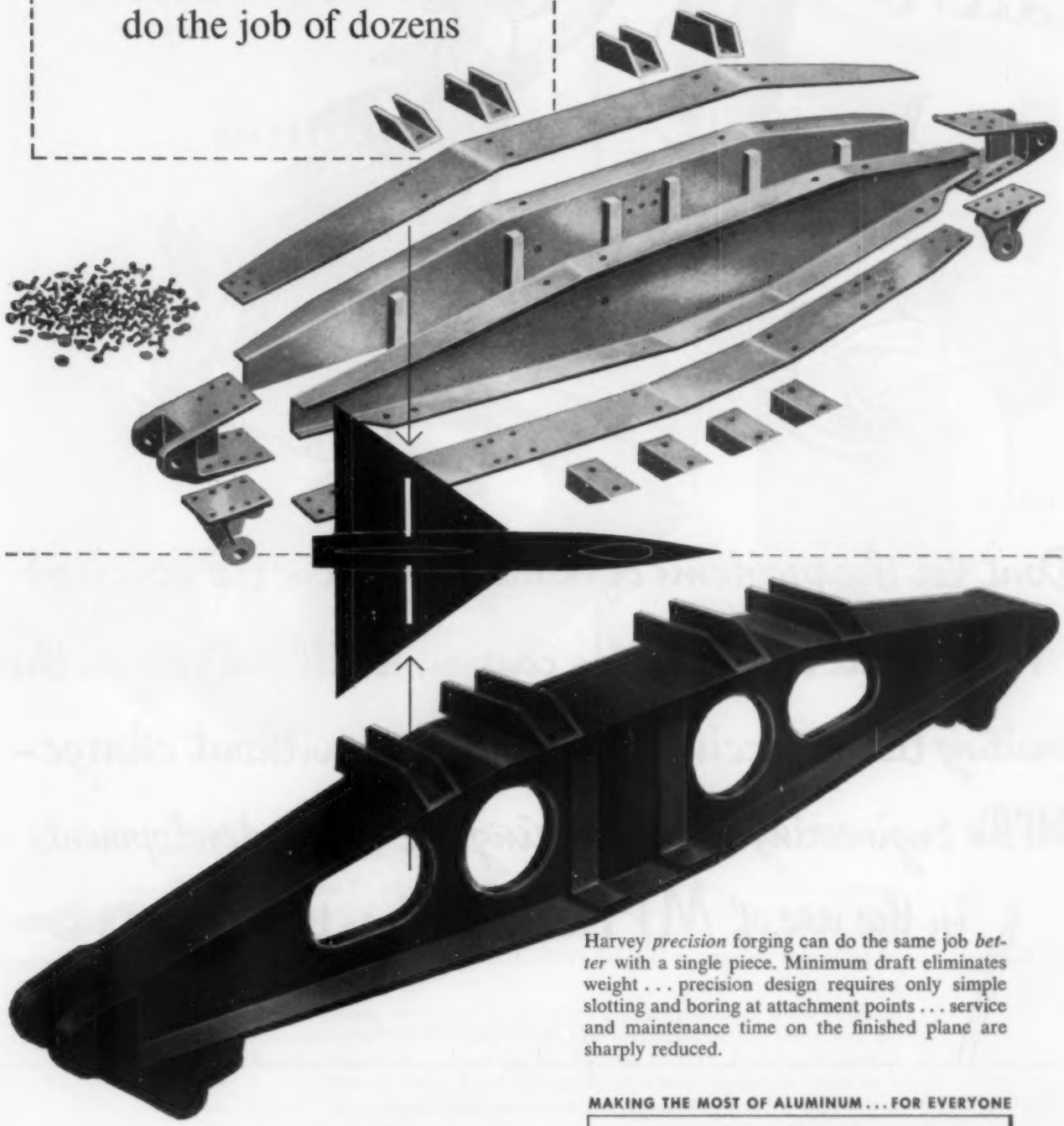
CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. GT

DIVISION OF FIRESTONE TIRE & RUBBER CO.

Harvey precision forgings... making one part do the job of dozens

Here's an aircraft beam . . . made the old way. Each one of the pieces you see must be handled separately, brought to an assembly area, laboriously put together with upwards of 40 bolts, almost 200 rivets. And it's only one of many similar beams in a typical modern plane.



Harvey *precision* forging can do the same job *better* with a single piece. Minimum draft eliminates weight . . . precision design requires only simple slotting and boring at attachment points . . . service and maintenance time on the finished plane are sharply reduced.

MAKING THE MOST OF ALUMINUM . . . FOR EVERYONE

HARVEY Aluminum

RESEARCH . . . DEVELOPMENT . . . PRODUCTION

Harvey does all three as a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tubes, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

HARVEY ALUMINUM SALES, INC., TORRANCE, CALIFORNIA—BRANCH OFFICES IN PRINCIPAL CITIES

Licked by a Dragon?

Don't let the problems of miniaturization tie you up!

Wield your blade on this coupon. It will put you on the mailing list to receive—bi-monthly and without charge—MPB's Engineering News, covering the latest developments in the use of MPB's ✳ such as these

BALL BEARINGS ACTUAL SIZE

CUT ON DOTTED LINE NOW

Miniature Precision Bearings, Inc., 4 Precision Park, Keene, N. H.

Please put me on your mailing list to receive the MPB "ENGINEERING NEWS"

name _____ title _____ company _____

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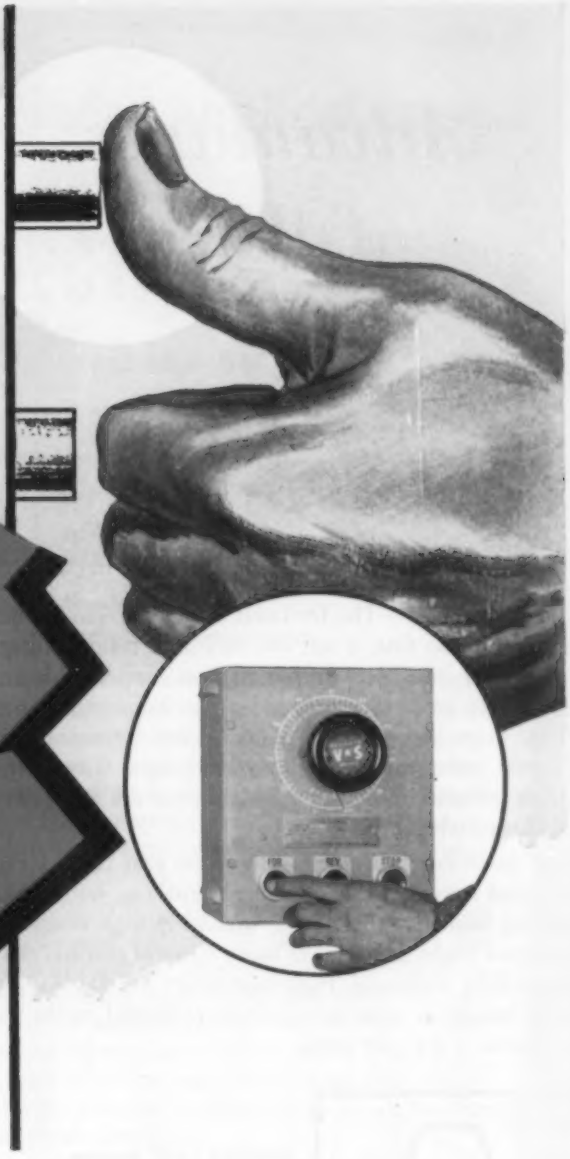
✳ MINIATURE PRECISION BEARINGS, INC., KEENE, N. H.

Everything's under control...

with the

RELIANCE V★S DRIVE ®



Smooth, versatile Reliance VARIABLE SPEED DRIVES are made to help you keep *everything under control!*

Dynamic response for rapid starting, stopping and reversing; hairline accuracy for maintaining required line speeds; positive, step-by-step assurance of optimum speeds during each processing cycle; precise delicate regulation of quantity, quality, color, shape, form and size . . . in fact, EVERYTHING is precisely controlled by Reliance V★S Drives.

For faster line speeds, smoother acceleration and deceleration, more sensitive tension control and other outstanding production dividends in *your* plant, call the nearest Reliance sales office . . . or write for Bulletin D-2311. *Reliance Electric & Engineering Co., 1080 Ivanhoe Road, Cleveland 10, Ohio; Canadian Division—Welland, Ontario.*

D-1498

RELIANCE ELECTRIC AND ENGINEERING CO.

Advantages of Worm Gearing

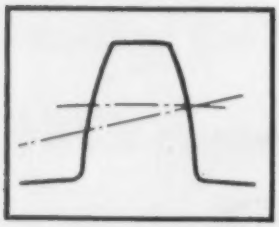
By J. E. GUTZWILLER

Assistant Chief Engineer, Worm Gearing Department

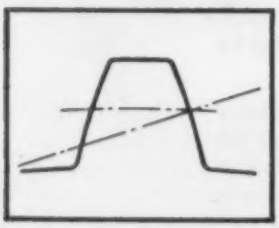
De Laval Steam Turbine Company

Interchangeability—The De Laval Steam Turbine Company was one of the first, if not the very first, manufacturer of heavy duty machinery to build worm gearing with interchangeable parts manufactured under limit gage control. Thus, worm and gear sets of like center distances but of different ratios can be readily interchanged if revision of speeds becomes necessary. Standard parts are always available for maintenance.

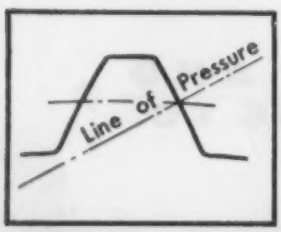
High Shock Load Capacity—The worm gear tooth form is such that the gear teeth are under a crushing, rather than a bending load. For this reason extremely high momentary and shock loads, damaging to many forms of gearing, can be successfully withstood. High momentary overloads seldom cause failure, as worm gear ratings are figured on the wear resistance of the gear teeth.



Standard 14½° involute spur gear tooth and old time worm tooth.



20° stub gear tooth.



De Laval Worm Gear Tooth. Note, line of pressure falls inside base of tooth.

Long Life—Bronze gear teeth maintain their correct form due to the regenerating action of the hardened steel worm, which retains its original shape throughout years of wear. A worm gear drive actually improves with service. This fact is peculiar to worm gearing and contributes to its recognized long life.

Smooth, Quiet Power—De Laval worm gearing transmits power by a continuous shockless action. Three or more teeth are in contact at all times, giving an even flow of torque and uniform angular velocity and eliminating vibration, pulsation, chatter and customary gear noises.

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Reference Manual On Worm Gear Sets

Design engineers will find this new catalog a helpful working tool in the selection of worm gear sets. It contains examples of how to select worm gearings, worm and gear data, standard worm mounting dimensions, horsepower ratings, data on shaft stresses as well as other information.

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DL 285

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At Right: Checking test data recorded on Brush instruments. Official photographs courtesy U.S. Navy.

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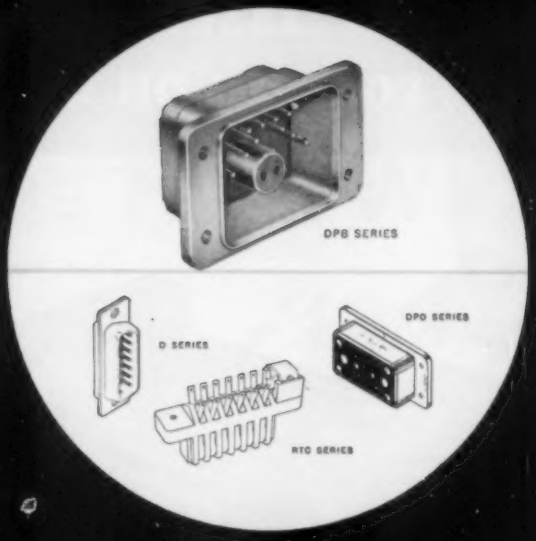

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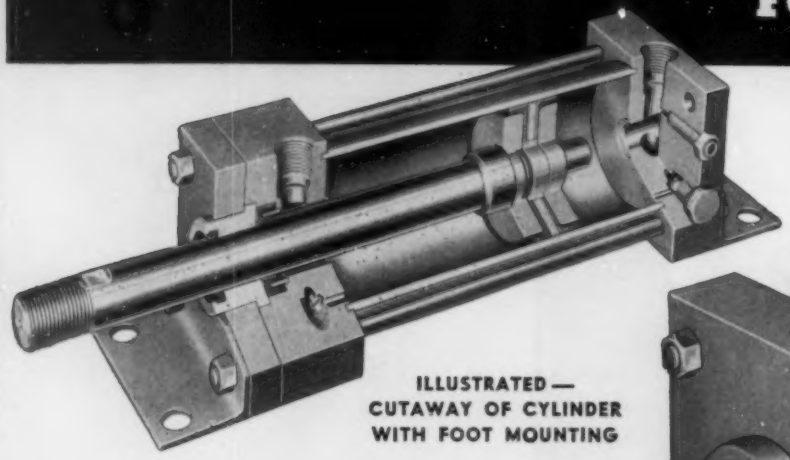

ILLUSTRATED — CUTAWAY OF CYLINDER WITH FOOT MOUNTING

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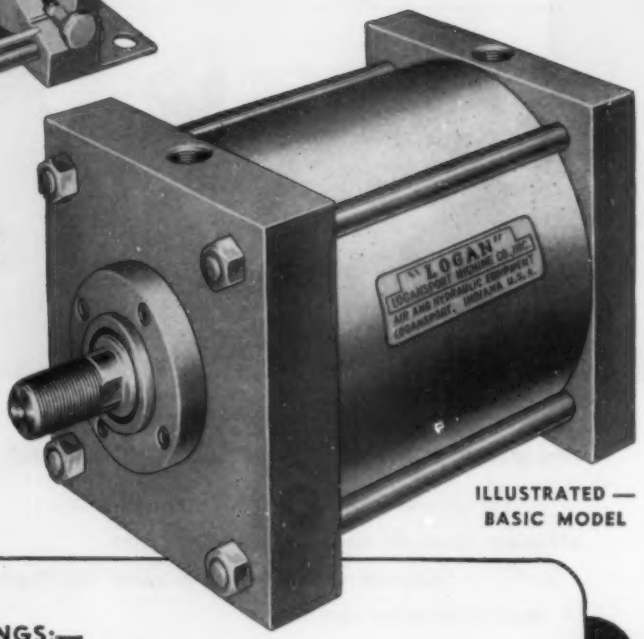

ILLUSTRATED — BASIC MODEL

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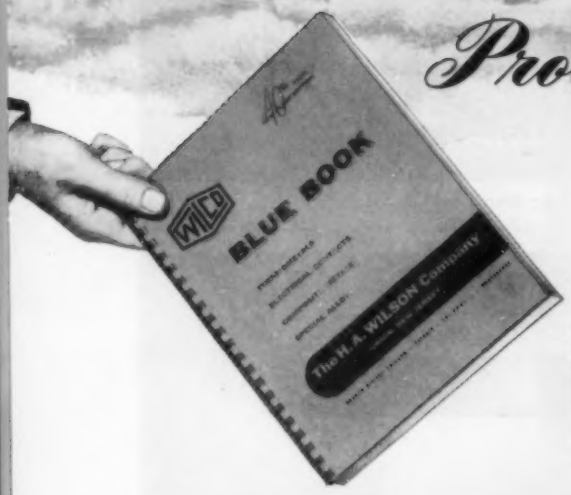

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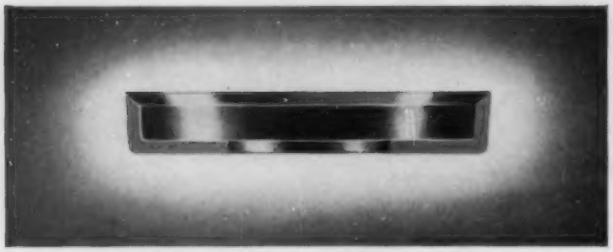
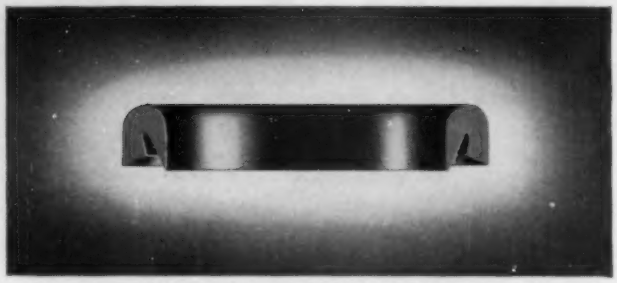
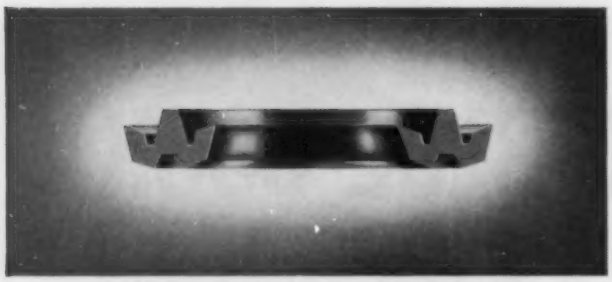


1. Type "A" Packing Cups for pistons *(the original "square heel" cup design)*

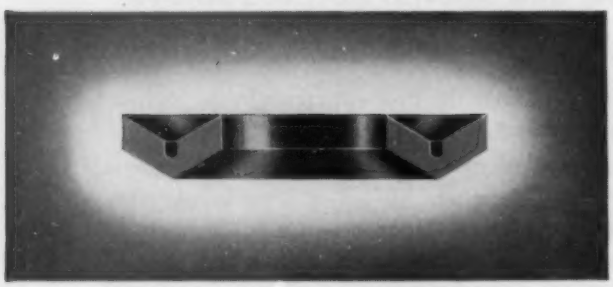


2. Sea Ring packing for rods

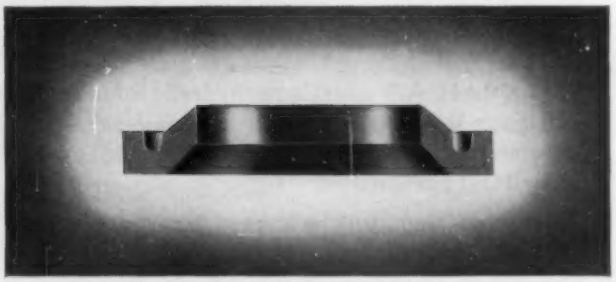


3. Uneepac Packing for rods and pistons

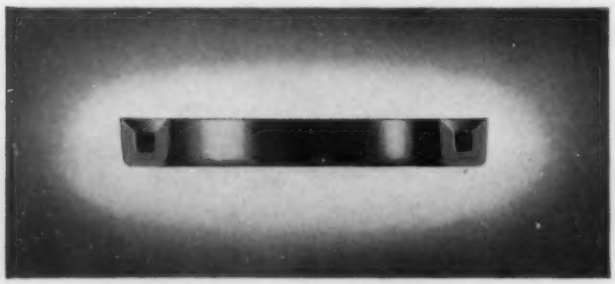
4. Hat Cup Packing for rods



5. V-Rings packing for rods and pistons



6. Cumpac #239 packing for rods



7. U-Cup Packing for rods and pistons

THE WIDE VARIETY of Johns-Manville Packing designs enables you to handle practically any sealing problem. The designs shown on this page are obtainable in a broad range of standard sizes and in materials designed for either usual or special service conditions encountered in hydraulic and pneumatic equipment. Johns-Manville also produces oil seals, moulded gaskets and miscellaneous shapes to specification. See your local J-M distributor or J-M sales office for product or engineering data. Or write Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ontario.

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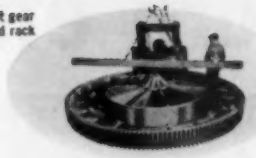
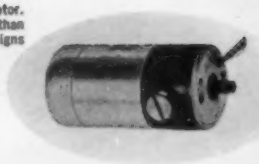
Torq-Master, used with torque converters and fluid couplings in the lumber industry

Giant gear and rack



Right angle vertical pump drive

Miniature motor. One of more than 50 basic designs



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Illustrated are only a few of the wide variety of both custom and standard products designed and manufactured by Western Gear.

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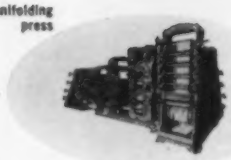
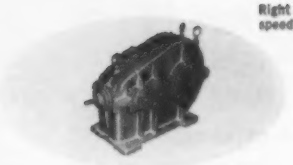
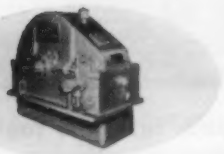




Right angle speed reducer



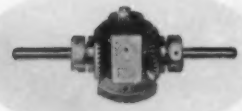
High speed unit

Centrifugal blower, one of many design sizes

Helicopter rotor drive unit

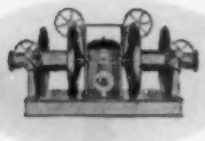
Sea-Master marine gear

Miniature precision differential unit



Aircraft cable drum type hoist, hydraulic, pneumatic or electr. drive

Trawl winch



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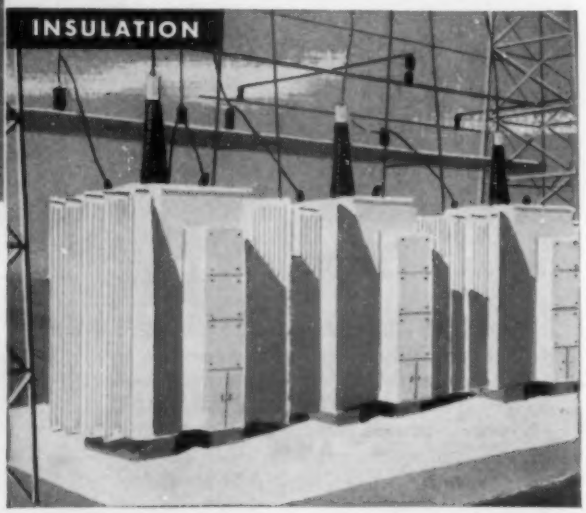

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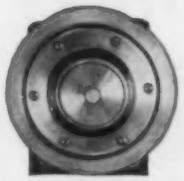

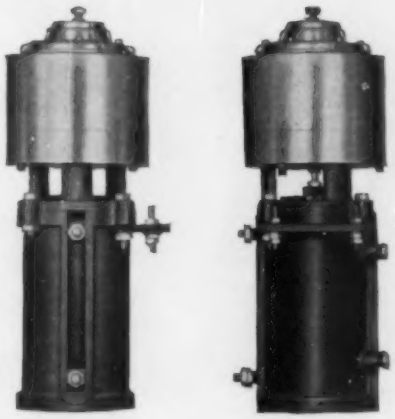

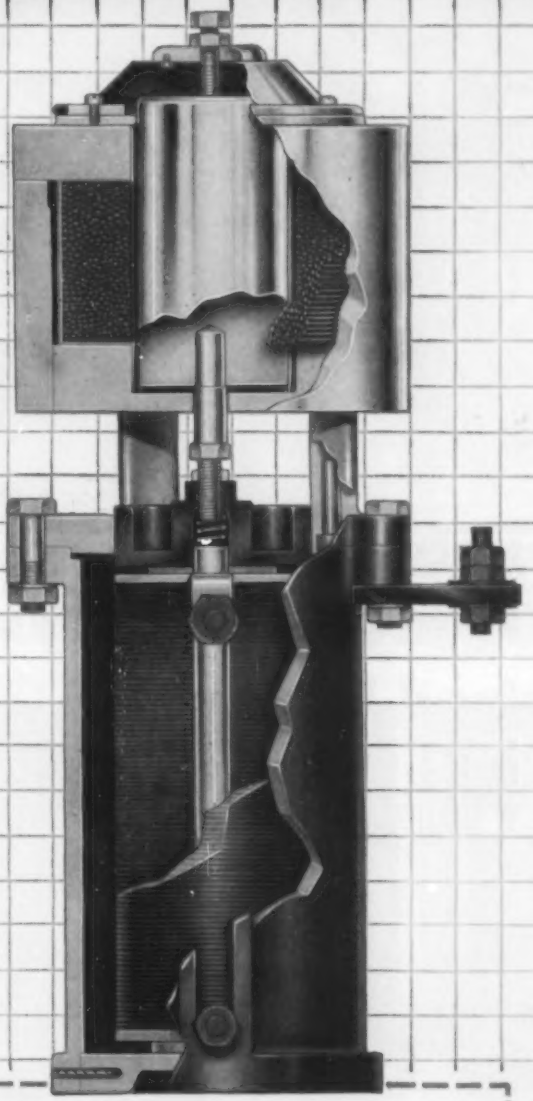

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For automatic control the SR-50 may be operated by a sensing element which responds to temperature, pressure, liquid level, tension, acidity or light.

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Control Requirements _____

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Name _____ Company _____

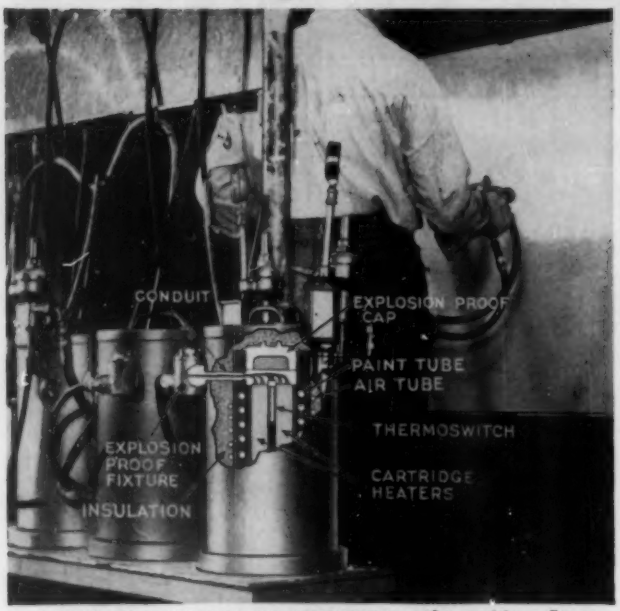
Address _____ City _____ State _____

SRC

Sonic Research Corporation

15 Chardon Street, Boston 14, Massachusetts

How would you solve these tricky temperature control problems?



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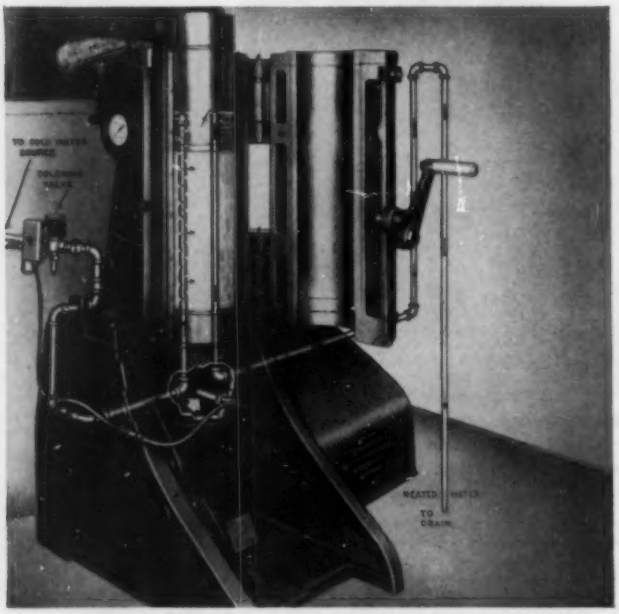
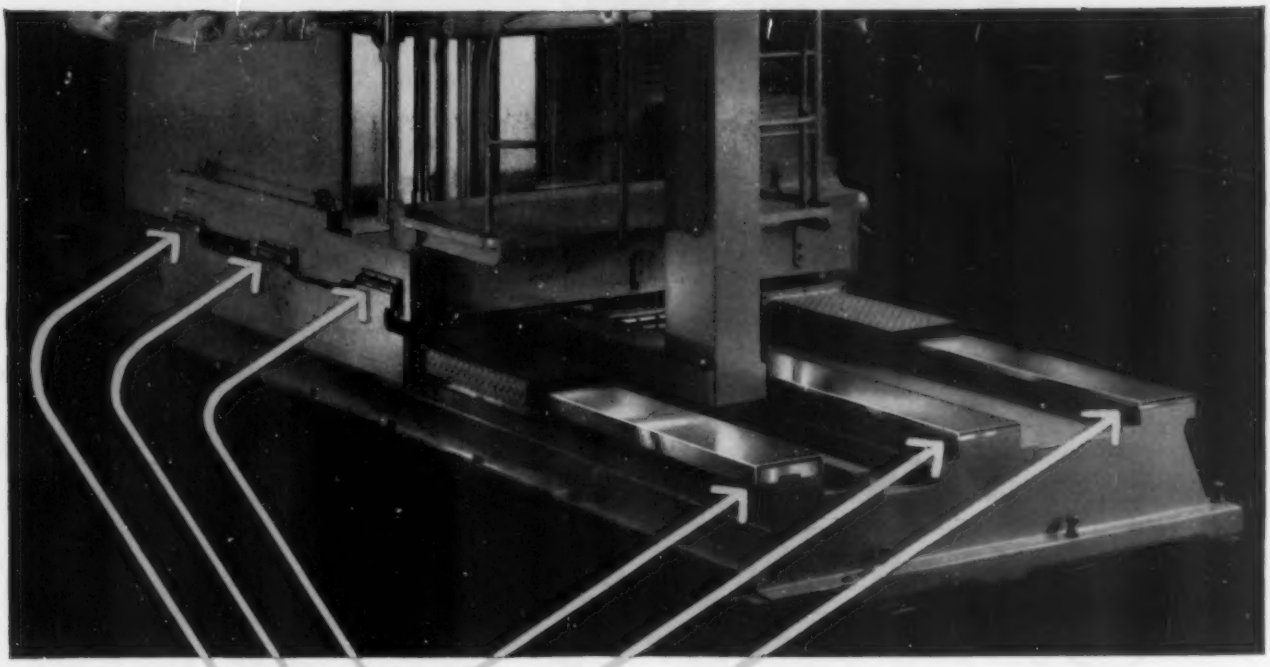


3. COOLING PRINTING PLATES. If printing plates cool too fast, they shrink — if too slow, they become porous. Reject plates were practically eliminated when a solenoid water valve was substituted for a hand valve — with a Fenwal THERMOSWITCH unit guarding the water temperature closely and operating the valve whenever the set point was passed. THERMOSWITCH shell itself "senses" change.

4. FREE CATALOG brings you complete data on the unique THERMOSWITCH unit. More details on problems discussed here if you want them. Fenwal engineers are always glad to help on special temperature control problems involving heat, humidity, pressure and other variables. Write **Fenwal Incorporated, 29 Pleasant St., Ashland, Mass.**

Fenwal **THERMOSWITCH®**

Controls Temperature — Precisely



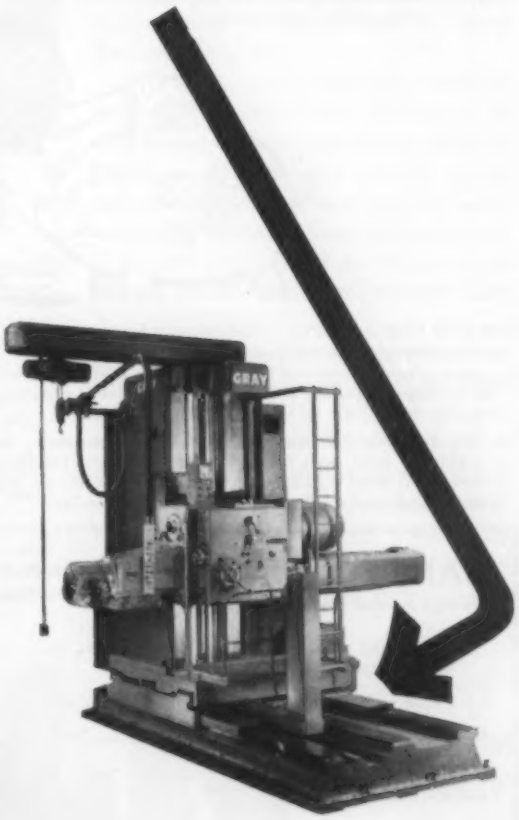
the G. A. GRAY CO. says OK hardened ways insure absolute accuracy during the long life of new 650 FC horizontal boring machine

THE G. A. GRAY CO., one of the world's most respected large machine tool builders, uses hardened and ground bedways and cross ways made by the Ohio Knife Co. In addition to insuring absolute accuracy during the long life of this machine, OK Hardened Bedways are the perfect mating surface for GRAY non-metallic bearing surfaces.

Specially heat-treated tool steel makes OK Ways practically wear-proof. Extreme hardness (65-66 Rockwell C) is uniform to a 3/16-inch depth or more. This is welded to a soft, tough steel backing under 2500 tons pressure, then precision ground to ±.0002 inches. OK Hardened Ways are available in a variety of shapes and sizes or can be made to suit your requirements.

THE G. A. GRAY CO. is one of many Machine Tool Show Exhibitors using OK hardened products as components. Look for OK products on machines at the big Show. They are a good index to over-all machine quality.

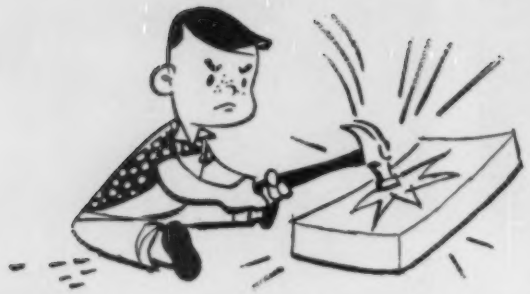
For free Ohio Knife bulletin, showing seven standard cross-sections in over 60 sizes, write Dept. 43-B



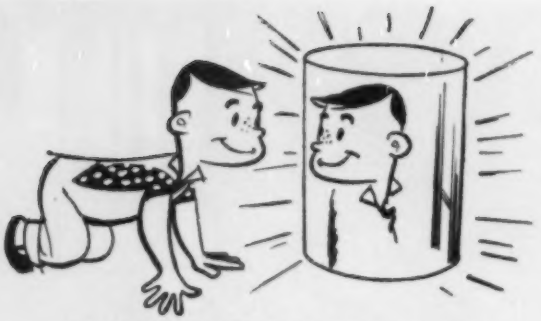
Slitter Knives • Shear Blades • Work-Rest Blades • Cut-Off Blades • Hardened Spacers • Hardened Ways • Gibs • Ball Races • Bronze Ways • Wear Strips

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO



High Impact Strength – CAMPCO can take it! Under the most rugged punishment – as toys, kitchen equipment, business machine housings – it retains its original finish and shape.



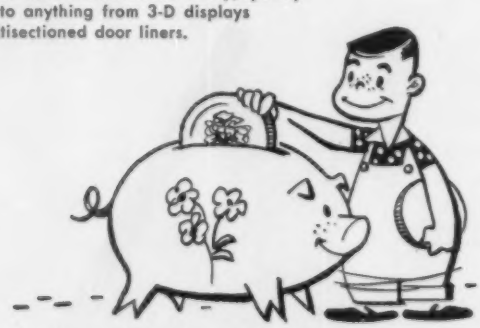
Porcelainlike Finish – CAMPCO's sparkling finish is unmatched wherever you want bright, porcelainlike appearance. That's why you see it so widely used for kitchen and bathroom products.

this is CAMPCO...

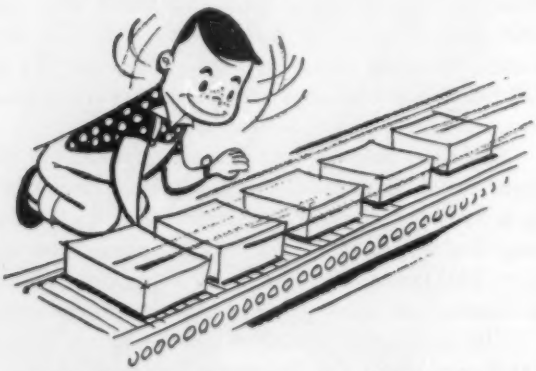
which of its advantages make it just right for you?

Takes Any Shape – if it can be made from sheet, you can do it with CAMPCO. It's easily, quickly formed into anything from 3-D displays to multisectioned door liners.

Any Color – CAMPCO comes in a full range of colors – opaque or translucent. What's more, you can paint or print on CAMPCO – it takes colors and printing beautifully.



Low Unit Cost – CAMPCO is custom-made for fast, low-cost vacuum forming. That's why your dies can be inexpensive wood, plaster or sprayed metal . . . why it's a lifesaver for packages, toys, any product where low price is vital.



Fast Production – Vacuum forming and CAMPCO are a natural combination for speed. On many products, it is possible to go from design to pilot production in 48 hours – using CAMPCO.

Try rugged, gleaming CAMPCO for yourself, and make up your own mind. Specify size and thickness, and we'll send you free test samples. There's no obligation, of course. Just mail the coupon, today.

CAMPCO Division
Chicago Molded Products Corporation

2726 Normandy Avenue
Chicago 35, Illinois

☐ Please send me CAMPCO samples_____wide by_____long by_____thick.

☐ Please send me detailed specifications on CAMPCO.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

CAMPCO DIVISION OF
CHICAGO MOLDED PRODUCTS CORP.

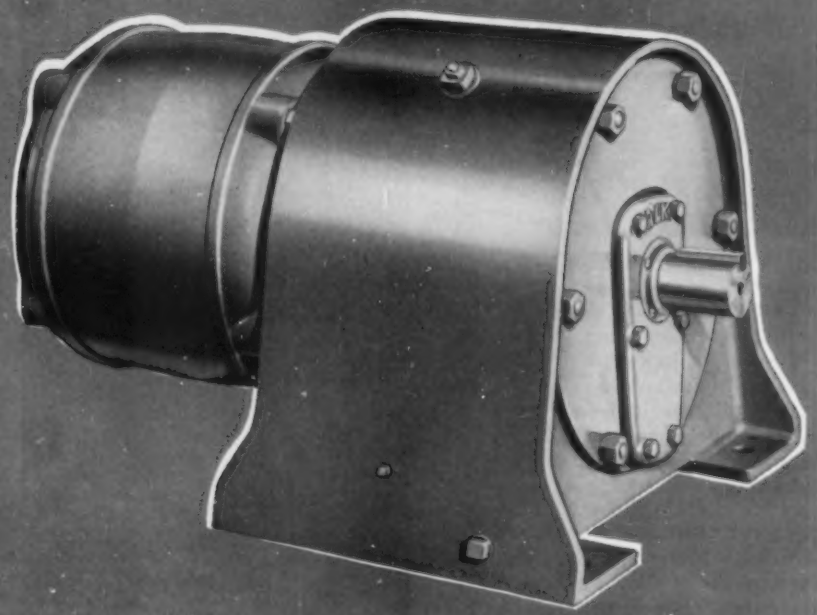
2726 Normandy Avenue
Chicago 35, Illinois

Announcing the *-Newly Designed-* Integral

ALL-STEEL FALK Motoreducer

(Gearmotor Type–Supplementing Falk All-Motor Line)

. . . with completely standard round-frame, D-flange motor

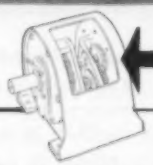


Check and Compare these features...

Meet a faithful old friend in a new, modern dress! The famous, time-proved Integral Type *all-steel* FALK Motoreducer (Supplementing Falk All-Motor Line) has been redesigned into a compact, streamlined unit providing the utmost in space economy—but retaining all the application versatility, long-life performance, easy-maintenance features and superior structural qualities that have made Falk Motoreducers the recognized standard throughout industry.

In this new Integral unit—rated in accordance with AGMA Standards—a *completely standard* round-frame, D flange NEMA motor is mounted directly on the all-steel Motoreducer housing. The motor remains a separate piece of equipment. Size and arrangement of the standard housing permit widest ratio range—from 3.36:1 to 542:1.

In order to meet the widely diversified needs of those who manufacture industrial equipment, the newly designed Integral Motoreducers are available in horizontal and vertical models, both in concentric and right-angle types; double, triple and quadruple reduction; horsepower range, 1 to 40 HP. Prompt stock shipment in standard ratios is offered. Write for Bulletin 3104.



Every FALK Motoreducer has these "In-built" Factors—

Precision Gearing. Heat treated alloy steel, precision cut and shaved helical gearing throughout . . . quiet-operating crown shaved pinions . . . taper bored gears for easy ratio changes.

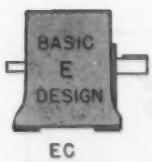
All-steel Housings. Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

Streamlined inside and outside. Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

Positive Lubrication. Large sump capacity . . . oil-tight construction assures clean lubricant . . . direct dip of revolving elements provides positive lubrication at all speeds.

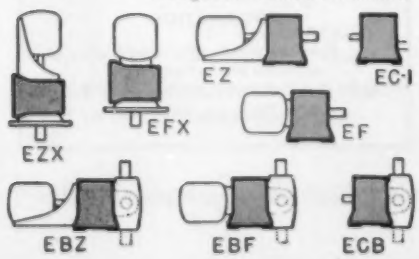
Wide Speed Range. Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

Sealed Housings. Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splash-proof, leakproof, dustproof.



EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



FALK ...a good name in industry

THE FALK CORPORATION · 3001 W. Canal St. · Milwaukee 8, Wis.

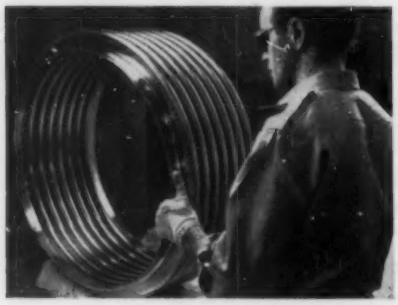
WRITE FOR BULLETIN 3104

APPLYING ATOMIC POWER?

Call on Solar skills with special metals for design and production of nuclear industry components

BUILDING FOR THE ATOMIC AGE calls for many special skills. For 28 years, Solar has been solving the problems that today confront nuclear engineers—extreme pressures, intense temperatures, corrosive conditions. Solar overcomes these hazards with highly precise fabrications of stainless steels, super alloys, titanium and other metals. This knowledge—expressed both in top quality contract production, and in the varied Solar proprietary lines—is now available to business firms and government agencies in the nuclear field.

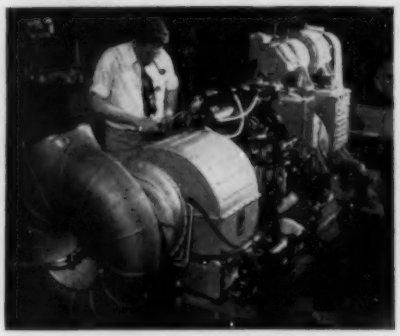
SOLAR BELLOWS for an AEC installation are shown below. They are one of several components being built currently for nuclear processes. In production they demanded strict surface perfection. The stainless steel nacelles pictured at bottom call for the expert forming and exact welding of half and full hard stainless steels.



Surface perfection required for AEC use

CURRENT PRODUCTION at Solar also includes pneumatic ducting, aircraft engine components and varied hard-to-build items for the petroleum, chemical and power industries where many of the problems of nuclear processes have been encountered.

Solar builds first stainless nacelles



Jupiter gas turbine is light, compact

GAS TURBINE ENGINES designed and built by Solar include the 50 hp Mars® and the 500 hp Jupiter. Their simplicity, ease of maintenance, high power output in relation to size and weight, and versatility make gas turbines the ideal prime mover for many specialized applications.

PROTECTIVE COATINGS developed by Solar have proven useful in extending the service life of alloy metals in cases where intense temperatures and highly corrosive conditions previously presented design limitations.

SOLAR OFFERS MORE than metal working skills and special products for atomic installations. A comprehensive research organization, and design, development and production engineering groups supplement manufacturing facilities. Solar research and engineering "firsts" include the first practical jet engine afterburner, the first hand started gas turbine engine, the first proprietary line of ceramic coatings for high temperature service, and many others dating back to the first stainless steel aircraft manifold.

PRODUCTION FACILITIES cover every type of metalworking—forming, machining, welding, brazing, casting, coating. Equipment ranges from precision experimental and tool shop machines to specially designed high production units. Solar has designed and built many of its own welding and fabricating machines for specialized needs. Some have proved so useful that they have been ordered by firms in the United States and Europe.

Research facilities include 19 test cells

Engineering task force studies control devices

COMPLETE QUALITY CONTROL—to meet rigid aircraft and commercial standards—plus government source inspection, assures products that meet specifications. Solar plants in San Diego and Des Moines have 1,400,000 sq ft of floor space and thousands of skilled employees.

LET SOLAR PROVE how its skills are "tailor made" for the production of nuclear industry components. Describe your requirements, and let a Solar task force demonstrate that Solar is your logical supplier.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

INFORMATION

For more information regarding any Solar product or service, write Solar Aircraft Company, Dept. B-61 San Diego 12, California

HOUGHTON VIM 1243-3 Rubber Impregnated LEATHER CUP PACKINGS are Tough!

0	1	4	5	6	0

Tough? look what happened in this "1500-mile" test made by a leading manufacturer!

A 10-months' test by one of the world's biggest manufacturers proved some sealing properties and endurance qualities that will impress—maybe astonish you—about our VIM 1243-3 packings.

Over 15 million cycles were made by our rubber-impregnated packings, at the rate of 1800 cycles per hour the first month, 3600 cycles per hour over the next nine.

Operation, at 100 p.s.i. in standard air cylinders with 3" stroke, was halted only for weekly leakage tests. No leaks were found at the end of the 300-day test—after the packings had "traveled 1456 miles"!

Engineers found the packings in such good condition that the test was discontinued . . . "exceptionally successful"!

Want more detailed information about the unique properties of VIM 1243-3 packings? Ask the Houghton Man for latest packing bulletin or write to E. F. Houghton, 303 W. Lehigh Ave. Philadelphia 33, Pa.

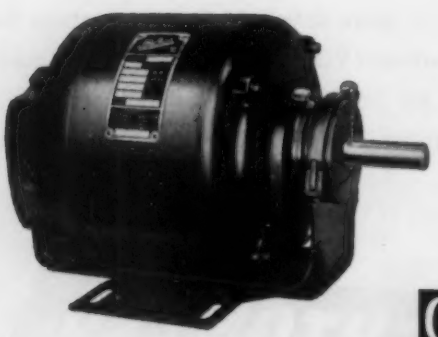
VIM and VIX-SYN PACKINGS
. . . **products of**

GET THIS "PACKING STANDARDS" BOOK
listing standard sizes accepted by industry. It will be mailed without cost to you.

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

One Satisfied Customer tells another...



But so does a *dis*satisfied customer! Then what? Best thing is to be certain in advance that all your customers will be *satisfied* customers. A sure way to do that is to standardize on Packard Electric motors for your appliances.

Packard fractional horsepower electric motors have been satisfying users for over 38 years . . . and satisfying manufacturers, too. They're good motors . . . they perform their jobs long and well. They deliver the kind of dependable, "we-never-think-about-the-motor" performance that builds increasingly greater customer acceptance for the products they power.

GM GENERAL MOTORS

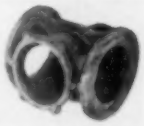
Packard

REG. U.S. PAT. OFF.

Packard Electric Division,
General Motors,
Warren, Ohio

WAUKESHA has the know-how to cast CORROSION-RESISTANT CASTINGS for many industries

to help solve your tough product design problems

CHEMICAL	PETROLEUM
	
Pump housing used in a chemical plant.	Valve body for petroleum industry.
DAIRY	**FOOD**
Pump housing for dairy equipment.	Screen frame for a juice extractor.
PAPER MILL	**INDUSTRIAL**
Casting for paper mill machine.	Filler bowl used in a plant.

Above are typical Waukesha corrosion-resistant castings from created metals that solved product design problems.

- **Why Waukesha—Broad Foundry Know-How and Successful Accomplishment** are at your disposal. An **Analytical Approach** to every casting problem contributes significantly to the right solution to your design problem. **Active Metallurgical Research** guarantees castings that are a valuable functional and sales asset to your products. **Corrosion-Resistant Metals,** whether of stainless steel or "Waukesha Metal" (a nickel alloy), are created to fit the precise corrosion-resistant needs of your castings. **Complete Facilities** are available to you . . . from engineering design counsel to the finished casting; and with delivery geared to your production schedule.

Why not rely on Waukesha to provide you with quality corrosion-resistant castings. **We suggest you write for a casting quotation or for engineering counsel.** Informative literature and corrosion-resistant information are available. Waukesha Foundry Company, 5503 Lincoln Avenue, Waukesha, Wisconsin.

Waukesha takes pride in its precise quality control standards and procedures.

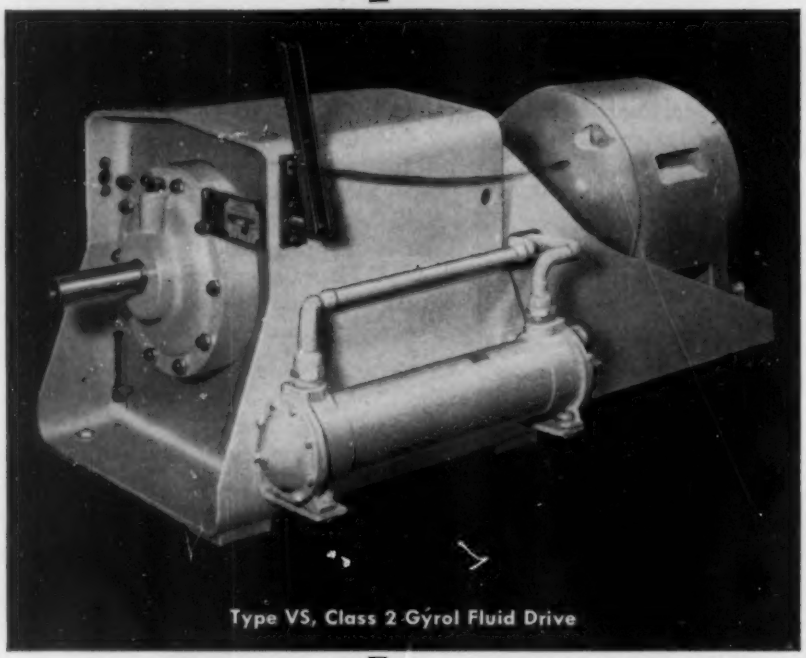
Waukesha Foundry Company

WAUKESHA, WISCONSIN

WAUKESHA: *SPECIALISTS IN CORROSION-RESISTANT CASTINGS FOR ALL INDUSTRIES*

American Blower Gyrol Fluid Drives are

Mighty Popular with Equipment Operators



Type VS, Class 2 Gyrol Fluid Drive

Here's why:

It's the flexibility and simplicity of Gyrol Fluid Drives that make them popular with equipment operators. No special motors or complicated starting controls are needed (saving power and maintenance costs); yet, Gyrol Fluid Drives offer operators such welcome features as adjustable, stepless speed control over a wide speed range, overload protection, smooth acceleration and complete shock absorption. These features reduce operator fatigue and strain because equipment operation is simpler and quieter.

You can get complete data on Gyrol Fluid Drives from your nearest American Blower Branch Office.

Typical Applications

PUMPS, AGITATORS, MIXERS
CONVEYORS, CABLE & ROPE MACH'Y
FANS AND BLOWERS
CENTRIFUGAL COMPRESSORS,
PAPER AND PRINTING MACH'Y
TEXTILE MACH'Y

Advantages of using Fluid Drive on Conveyors

Besides providing smooth acceleration, Gyrol Fluid Drive is an excellent means of adjusting conveyor speeds to suit process or production demands. With manual control, the conveyor can be operated at speeds well below normal speed, can even be stopped completely without shutting down motor. If conveyor jams, the Fluid Drive acts as automatic shearpin since output shaft stalls until jam is cleared.

American Blower products serve industry

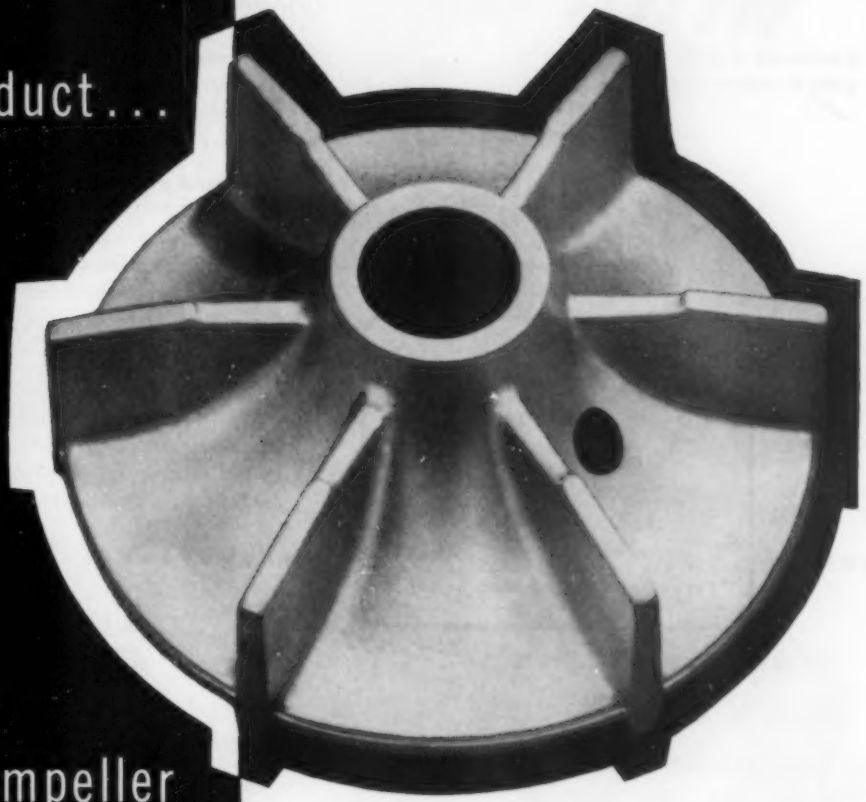
- AIR CONDITIONING, HEATING, VENTILATING EQUIPMENT
- MECHANICAL DRAFT EQUIPMENT
- INDUSTRIAL FANS AND BLOWERS
- CENTRIFUGAL COMPRESSORS
- GYROL FLUID DRIVES
- DUST COLLECTORS

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

another case where
MUELLER BRASS CO.
FORGINGS
improve a product...



diesel engine
water pump impeller
forged of "603" **HIGH STRENGTH BRONZE**

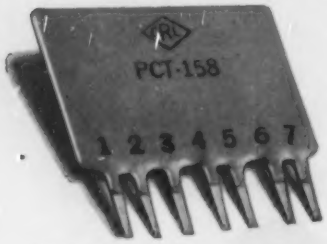
Formerly produced as sand castings, these impellers now give better results because they're forged from "603" high strength bronze by the Mueller Brass Co. Said to be "right for the job and far superior to the old cast impellers", these forgings bring greater efficiency and longer life to the diesel engine water pumps in which they are installed. This tough "600" series alloy is readily forgeable, possesses remarkable resistance to corrosion, and has fine bearing qualities. Uniformity is excellent, due to the closer dimensional control of the forging process, and surface finish is noticeably smoother. This is another case where Mueller Brass Co. forgings have greatly improved a product . . . why not let our engineers show you the many advantages of using forgings.

MUELLER BRASS CO. STREAMLINE PRODUCTS

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

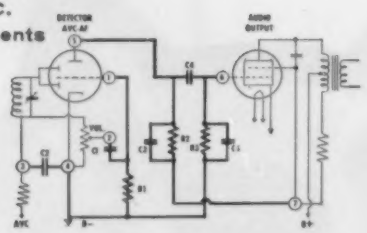
Utilizing modular design for electronic circuitry?



Centralab can help you

— with packaged electronic circuits . . . "tinkertoy" plates . . . authoritative counsel

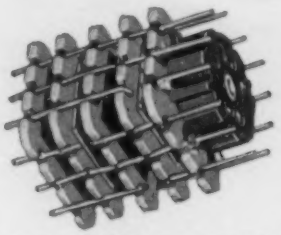
Centralab P.E.C. with 8 components



Planning on "rolling your own" and assembling a circuit from scratch? That's one place Centralab can help you. For Centralab can supply "tinkertoy" plates the way you want them — bare or with components attached.

Or would you rather save design and assembly time, by buying performance, instead of parts? Centralab can help you there, also. Centralab "packages" electronic circuitry — physically reduces a complete circuit, with all wiring, resistors, capacitors, and small inductances, to a two-dimensional form. You save space and weight — and you get a complete, sub-assembly "package" that is tested and guaranteed for specific performance.

Which way should *you* go? Talking it over with Centralab engineering specialists can help you decide, just as it has helped others. But—and this is important—call in Centralab *early* in the planning stage, *before* you've "frozen" your design.



"Tinkertoy" with 8 components

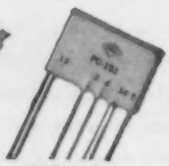
More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry

Volume Controls

Capacitors

Switches



Packaged Electronic Circuits

Ceramics

NEW THIS MONTH!
Electroni-Kwiz No.7

1st Prize

Matched set of cowhide luggage — including
1. Two-suiter 2. Brief bag

A combination you're proud to own. Like to try for it? Simply answer this question in 50 words, more or less:

If a young man — perhaps your son—wanted to pursue an engineering career in the field of electronics, how would you advise him to prepare for it?

A leading editor will pick the winner of this month's major prize.

Mail your entry to us before September 30.

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab—none can be returned.

Y-556

Centralab
A DIVISION OF GLOBE-UNION INC.
9181 E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

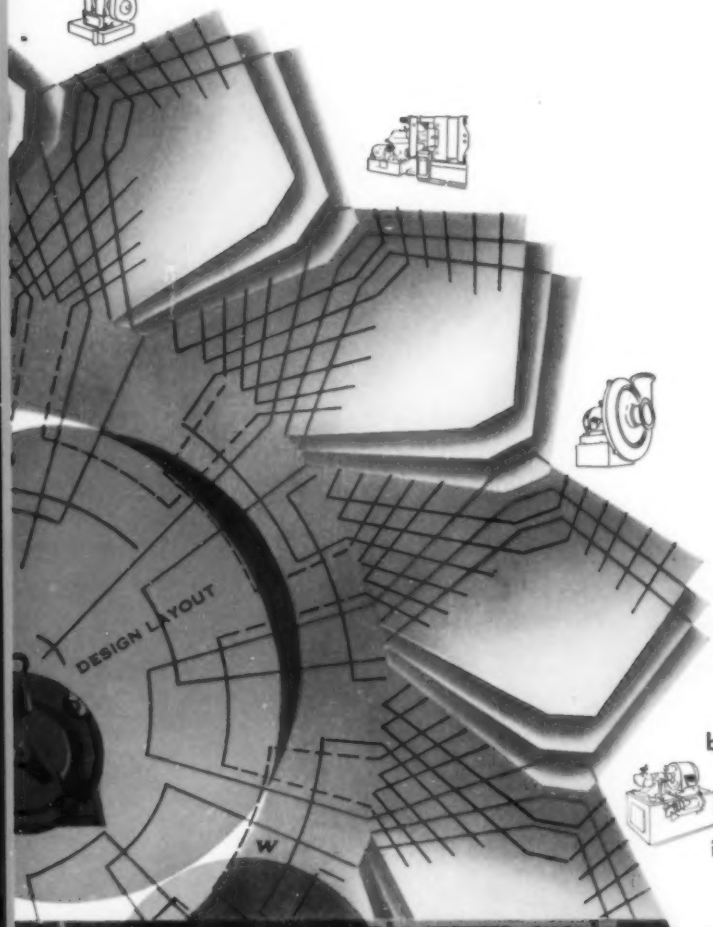
*Trademark

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

THE MARK OF AN EXTRA DEPENDABLE MACHINE

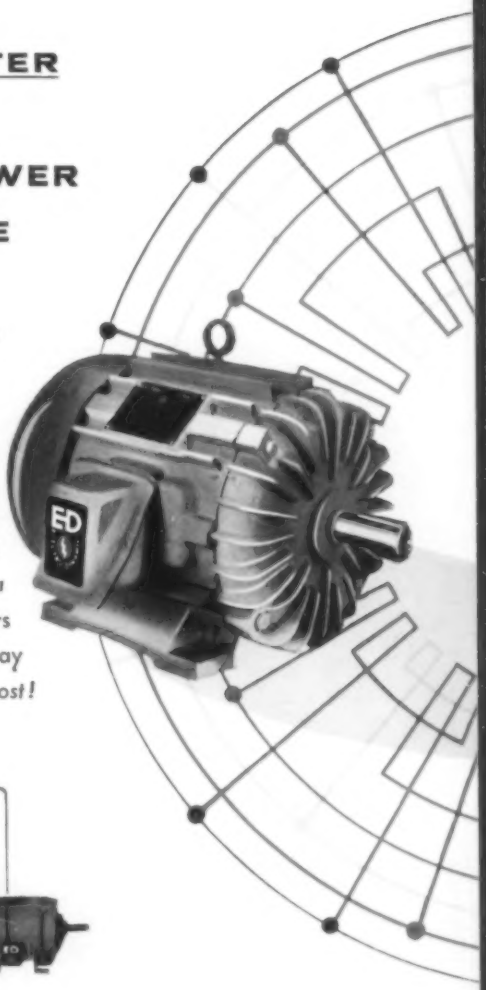
ED ELECTRO DYNAMIC

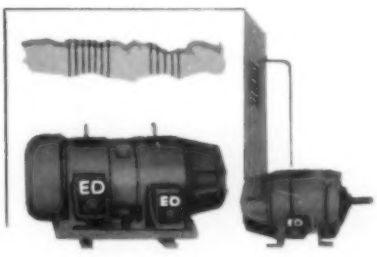
75TH ANNIVERSARY 1880 — 1955



A BETTER KIND OF POWER PACKAGE

Extra starting and anti-stalling capacity. Extra cool, extra quiet operation. Achieved without sacrifice of full-load efficiency. Backed by unparalleled experience E. D. motors are *extra dependable*...75 years in the making...yours today *at no extra cost!*





"Selectrol" Variable Speed Drives for *extra dependable* automation.

Gear-ED-motors offer a wide choice of speeds.

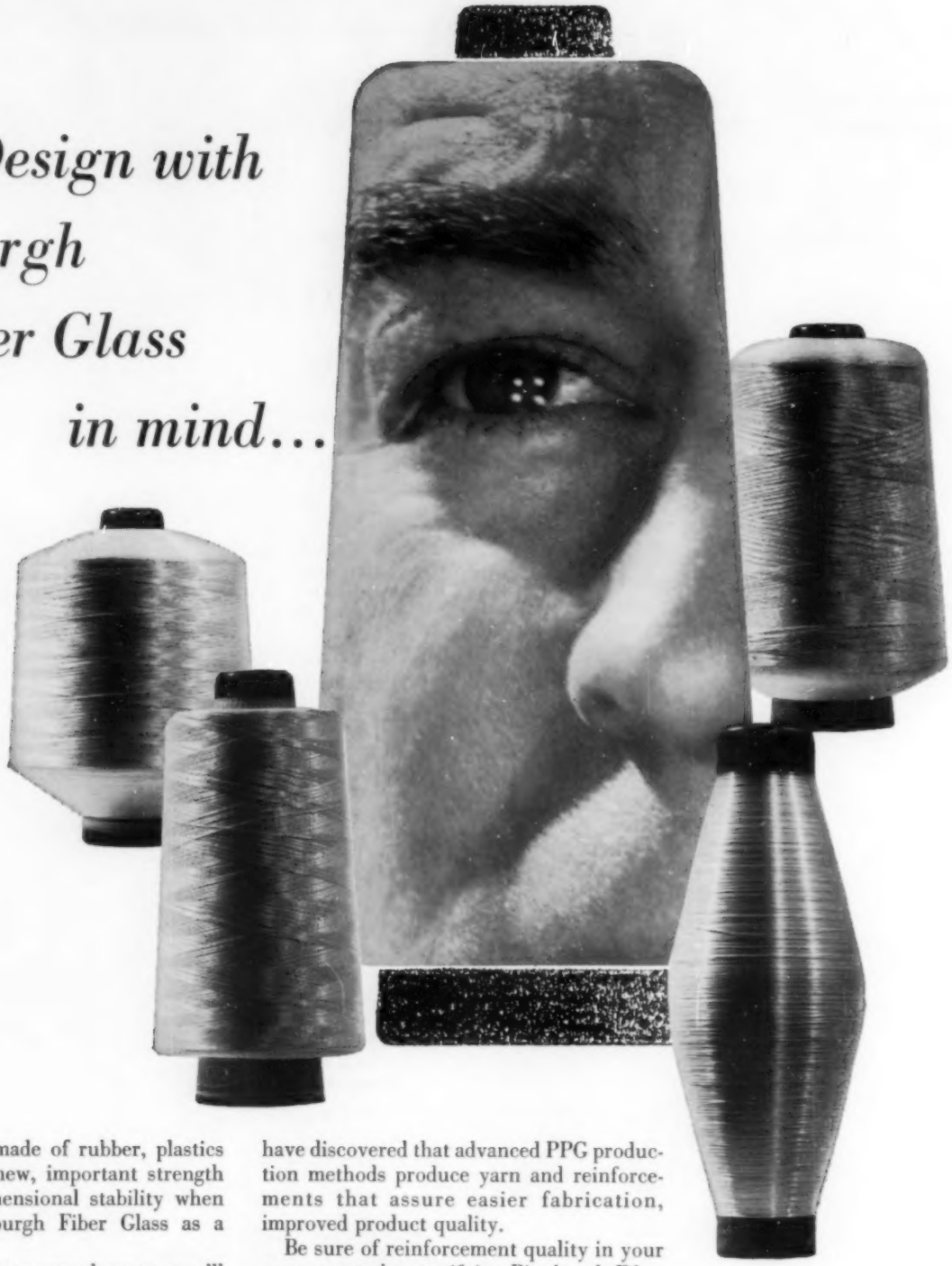
ELECTRO Extra DYNAMIC *ependable motors*

PRODUCT OF GENERAL DYNAMICS

GD | ED | EB | GA | C-L | C-V

1500 Write for literature to: **ELECTRO DYNAMIC** DIVISION OF GENERAL DYNAMICS CORPORATION, BAYONNE, N. J.

Design with Pittsburgh Fiber Glass in mind...



Component parts made of rubber, plastics or paper take on new, important strength and additional dimensional stability when you specify Pittsburgh Fiber Glass as a reinforcement.

In housing and structural parts, you'll add excellent dielectric strength when reinforcing cloth containing Pittsburgh Fiber Glass is specified for laminates used in making such parts.

Yes, the design trend is to fiber glass reinforcements—and specifically, to Pittsburgh Fiber Glass, because of its exceptional quality. Manufacturers and molders alike have discovered that advanced PPG production methods produce yarn and reinforcements that assure easier fabrication, improved product quality.

Be sure of reinforcement quality in your components by specifying Pittsburgh Fiber Glass. For complete information and technical staff assistance, write our executive offices or sales offices in Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Los Angeles, New York, Philadelphia or St. Louis. Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.

FIBER GLASS PPG

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PITTSBURGH PLATE GLASS COMPANY

DESIGNING WITH ALUMINUM

NO. 15

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

ALUMINUM vs. STEEL STRUCTURALS

THE light weight, strength and corrosion resistance of aluminum alloys are causing them to be increasingly considered for applications where structural steel has been the traditional material of construction.

Aluminum weighs about 0.10 lb. per cubic inch, structural steel about 0.28, or nearly three times more. Aluminum structures weigh from 35% to 70% of their steel counterparts, which suggests a number of economic advantages to be gained through the use of aluminum:

1. Ease of handling light sections in the fabricating shop.
2. Reduced shipping and erection weight—hence, the possibility for greater off-site fabrication.
3. Reduced erection time with attendant reduction of construction costs and earlier placement of the structure in service.

It also points up applications wherein the fullest advantage of weight reduction is to be gained:

1. Long-span structures in which the greatest load is the weight of the structure itself.
2. Structures whose component parts must be shipped long distances and erected in difficult-to-reach locations.
3. Structures which are difficult to erect or which must be erected without the aid of heavy lifting equipment.
4. Structures in which demountability or portability is a requirement.
5. Mobile structures which impose a dynamic load on their supports and may have power requirements.
6. Structures located in areas where expensive foundations are required.
7. Applications which impose additional loads on existing structure.

Aluminum alloys are highly resistant to atmospheric corrosion. No surface treatment is required for most of the alloys used in structural applications. This is an obvious advantage over structural steel which must be initially protected by galvanizing or painting, and periodically repainted during the lifetime of the structure.

Corrosion resistance therefore suggests additional economies, beyond those found in weight savings, for aluminum structural applications:

1. Exposed structures, particularly those located in industrial atmospheres and areas of high humidity.
2. Structures which are expensive to repaint because of location or intricacy of detail.
3. Structures which must be taken out of service to allow maintenance.
4. Structures composed of light members in which arbitrary corrosion allowances determine the minimum thickness of steel members permissible in the design.
5. Applications in which an attractive, permanent finish is required.

Well-designed aluminum structures weigh considerably less than similar steel structures. This is due not only to aluminum's low density in relation to steel, but also to the strength and elastic properties of the aluminum alloys. Figure I lists certain of the typical and minimum tensile properties of several of the aluminum alloys commonly used in structural applications, and those of structural steel.

It will be observed that the tensile yield strength of alloy 6061-T6 compares with the yield of structural steel while the ultimate tensile strength of alloy 2014-T6 is the same as the ultimate of steel. Since permanent deformations in a structure caused by stresses in excess of the yield strength of the material are generally considered undesirable, design working stresses are usually selected by applying a suitable factor of safety to yield strength. On the basis of yield strength, then, a 6061-T6 tension member would carry the same load as an identical structural steel member and weigh less than ⅓ the steel member.

All aluminum TV antenna at Long Beach, California. Prefabricated in approximately 20-foot sections.

Some designers apply a somewhat greater factor of safety to the tensile yield strength of the aluminum alloys than to that of steel because of the difference in spread between yield and ultimate. It is important to note that even if the same safety factor were applied to the minimum ultimate tensile strength of 6061-T6 and structural steel, the 6061-T6 member would weigh less than half that of a steel member carrying an equivalent tensile load. In addition, the aluminum member would provide a greater margin of safety against permanent deformation.

FIGURE I

		Typical Tensile Properties			Minimum Tensile Properties		
Metal	Alloy and Temper	Yield Strength PSI	Ultimate Strength PSI	Elongation % in 2"	Yield Strength PSI	Ultimate Strength PSI	Elongation % in 2"
Al.	2014-T6*	65,000	71,000	10	55,000	60,000	7
Al.	5083-O†	22,000	44,000	21	18,000	40,000	16
Al.	5083-H112§				24,000	40,000	12
Al.	5083-H113†	33,000	46,000	16	31,000	44,000	12
Al.	5086-O†	17,000	38,000	22	14,000	35,000	18
Al.	5086-H112†	19,000	39,000	14	18,000	36,000	8
Al.	6061-T6	40,000	45,000	17	35,000	38,000	10
Al.	6063-T5	25,000	30,000	12	16,000	22,000	8
Al.	6063-T6	30,000	35,000	12	25,000	32,000	8
Steel	ASTM-A7	38,000	60–72,000	30	33,000	60,000	24

*Fusion welding of 2014 not recommended. †Plate properties.
§As extruded. Typical mechanical properties vary according to size and shape of structural sections.

PLEASE TURN TO NEXT PAGE

In many cases, the stiffness of a structural member is the governing factor in design and stiffness is a function of the modulus of elasticity of the material of construction. The modulus of elasticity of the aluminum alloys is about 10,300,000 PSI while that of structural steel is 29,000,000 PSI. Hence, it will be seen that an aluminum beam will deflect the same amount under its own weight as an identical steel beam, since the aluminum beam will weigh but ⅓ the steel beam. Under the same applied load, the aluminum beam will deflect up to almost three times that of the identical steel beam depending upon the relation of dead load to total load.

If, under the same conditions of loading, stiffness equal to steel is required of an aluminum beam, it can be achieved—with substantial savings in weight—by selecting an aluminum beam having increased section properties. For example, a 7" aluminum I-beam weighing 5.42 lbs. per foot has three times the moment of inertia of a 5" steel I-beam weighing 10.0 lbs. per foot, nearly twice as much. Thus, equal stiffness is provided and stresses due to bending in the aluminum beam will be less than half those in the steel member.

To take full advantage of the high strength of the aluminum alloys, deflection criteria should be closely examined to make certain that the design is not needlessly penalized by arbitrary and unnecessarily severe deflection limitations. Reducing deflection through the use of rigid framing and continuity should not be overlooked. The maximum deflection of a uniformly loaded, continuous beam of two equal spans is less than half that of a simply supported beam if unsupported length, loading and beam section properties are equal.

The elastic modulus also affects the stability of compression elements. For example, the load to cause elastic instability of an axially loaded slender column is directly proportional to the modulus of elasticity of the metal used. Hence, an aluminum column will carry but ⅓ the load of an identical steel column, but will weigh only ⅓ as much as the steel column. By selecting a somewhat heavier aluminum section, it is possible to support a load equal to that of the steel column with substantial weight reduction. For example, an 8" x 8" wide flange aluminum column will support about one-half again as great an axial load as an 8" x 5" wide flange steel column of the same length before becoming elastically unstable. Yet, the aluminum member weighs 11 lbs. per L.F., the smaller steel section 20 lbs. per L.F.—nearly twice as much.

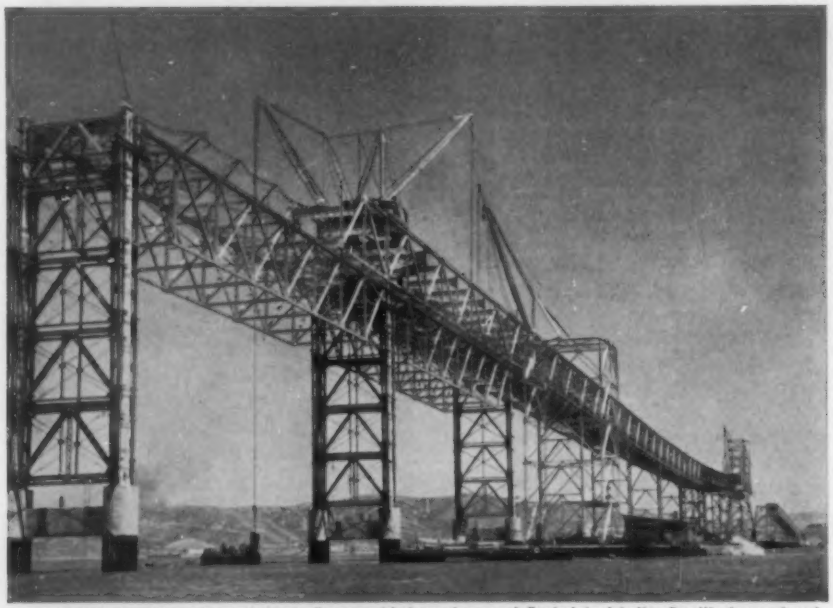
Aluminum's lower elastic modulus has a beneficial effect in absorbing impact loads and reducing stresses caused by inexact fit-up of members in a structure. Because of the lower modulus, stresses induced by temperature changes in restrained members are less for aluminum than for steel. This is in spite of the fact that the coefficient of thermal expansion of aluminum is about 0.000012 in/in/°F, or almost twice that of steel.

Procedures involved in the fabrication of aluminum and steel structures are comparable. As with steel, joining can be accomplished by riveting and bolting. Aluminum rivets and bolts are usually used in aluminum structures for maximum corrosion resistance. Either hot or cold driven aluminum rivets can be used. Holes for aluminum rivets and bolts in primary structural members are drilled or subpunched and reamed and aluminum members are sawed, sheared or cut with a router rather than flame cut.

Aluminum members can also be joined by welding. Allowable stresses across welds are reduced to offset a certain reduction in strength in the heat affected zone. Two new alloys, 5083 and 5086, recently developed by Kaiser Aluminum, show great promise for welded aluminum structural work. Inert-gas arc welds of these alloys in plate and sheet exhibit joint efficiencies varying from 80% to 100%, depending on the original temper of the base plate.

Hence, the use of standard aluminum structural shapes offers exciting possibilities to the designer in the development of efficient structural solutions. In addition, the extrusion process makes possible the economical production of special aluminum sections for unique design situations. Kaiser Aluminum engineers, experienced in the design of aluminum structures, will welcome the opportunity to assist you in designing with aluminum.

Contact the Kaiser Aluminum sales office listed in your telephone directory or one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office:* Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois; *Executive Office:* 6979 Kaiser Building, Oakland 12, California.



285' riveted aluminum falsework truss. Preassembled on shore and floated to jobsite. Readily lowered and moved between towers in its use as erection platform for construction of San Rafael-Richmond, California bridge. Weight 110 tons. Estimated weight in steel approximately 300 tons.

Kaiser Aluminum

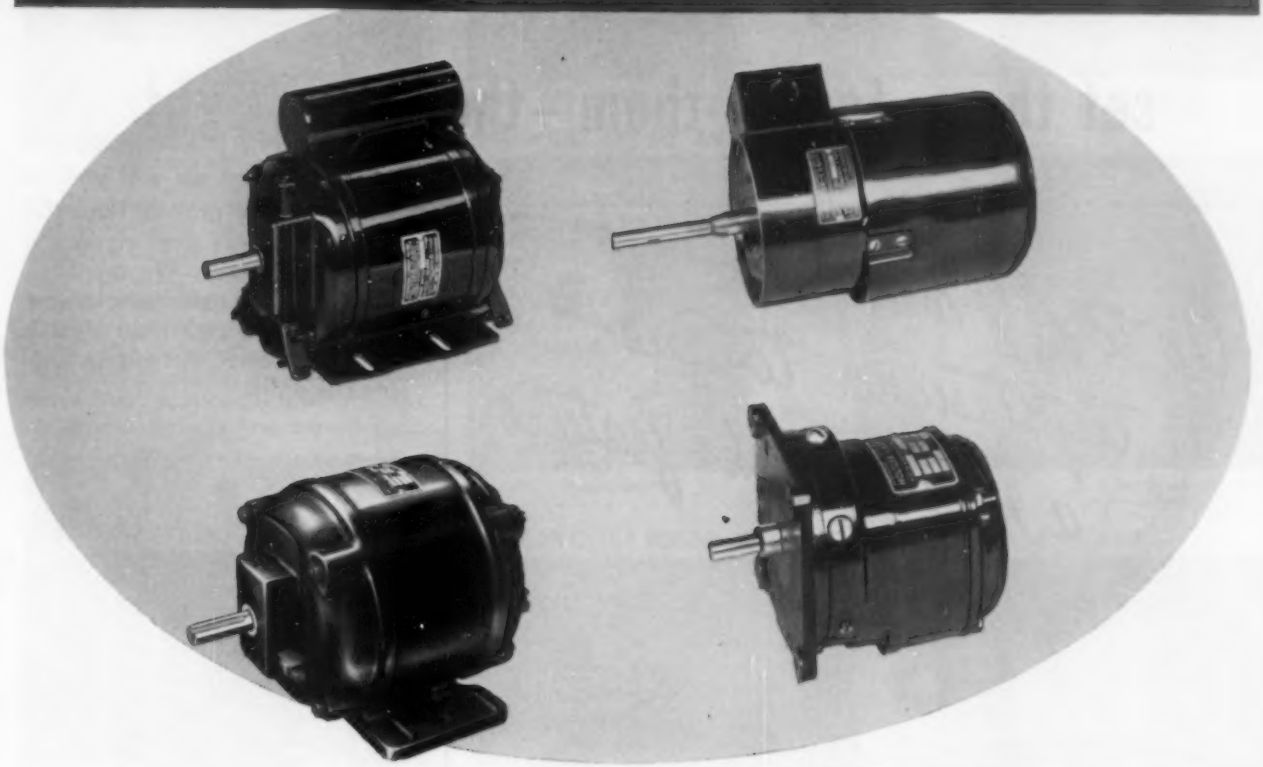
see our catalog in PRODUCT DESIGN FILE or write for copy

setting the pace—in growth, quality and service

HOLTZER-CABOT

Fractional Horsepower Motors

1/200 to 1 H. P. - 3" to 7" frame diameters - single phase, polyphase, direct current



Holtzer-Cabot fractional horsepower motors are available in an extensive range of electrical types, frame diameters, lengths, mechanical and electrical variations. This wide range permits the selection of the ideal motor for your product. Or, if needed, our highly skilled personnel can develop, promptly and efficiently, special custom-built motors for your specific applications.

The following basic motor designs are available for 60-cycle operation. Most of the a-c designs have d-c companions. Electrical variations include: voltage, frequency, single or polyphase operation. Partial motors, for direct insertion into your product, are also available.

ELECTRICAL TYPES

- SPLIT PHASE
- CAPACITOR
- SYNCHRONOUS
- REPULSION INDUCTION
- SERIES AC OR UNIVERSAL
- DIRECT CURRENT
- POLYPHASE
- MULTI-SPEED
- RAPID REVERSING
- GENERATORS

These types can be combined to provide motor-generator sets, inverters, dynamotors, frequency changers, and countless varieties of electrical apparatus (up to 7" in diameter) which are not normally classed as motors or generators.

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TYPICAL MECHANICAL FEATURES

Ball or sleeve bearings
Special mountings: resilient, laminated steel spring or rubber, flange, face, vertical
Open or totally enclosed
Special shafts — unlimited variations; double shafts to 43" long
Special lubrication for any mounting position or operating condition
Special shapes, e.g. "pancake" type with short axial length
Partial motors

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN ☐ Please send me complete design information on Holtzer-Cabot fractional horsepower motors.

☐ Please have representative call..... (date)

Name.....

Title.....

Company.....

Street.....

City.....*Zone*...*State*.....

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125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

New High-Torque Unbrako self-locking socket set screws

set them, forget them—they stay tight

Up to 40% higher tightening torque—a new Unbrako feature

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (Inch-Pounds)

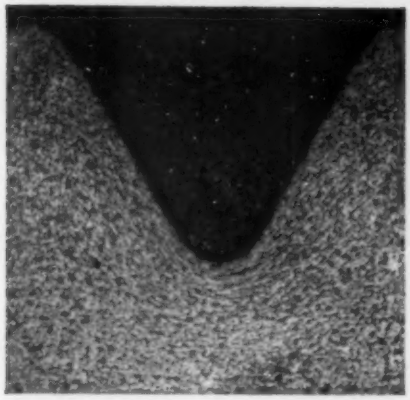
SCREW SIZE	UNBRAKO	B	C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

All UNBRAKOS can withstand higher tightening torques than ordinary set screws. For example, the recommended torque for a ¼" UNBRAKO is 87 inch-pounds —40% greater than that recommended for an ordinary set screw.

Research has proved that the tighter you seat a set screw the better it works. We went to work to design a socket set screw that could be tightened tighter than ever before without damaging the screw.

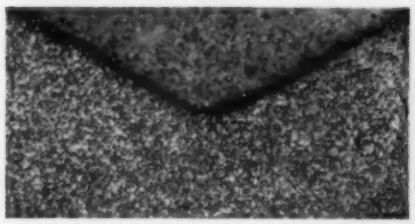
We formed a deeper socket. We put a radius in the socket corners. We developed fully formed threads. We established new methods of heat treatment in atmosphere-controlled furnaces. It took almost 6 years' research and development, but the new High-Torque UNBRAKO incorporates all of these improvements. And it retains the self-locking knurled cup point that keeps an UNBRAKO tight up to 48 times as long as a plain cup point set screw, regardless of the size of the point or the cup.

UNBRAKO SET SCREW



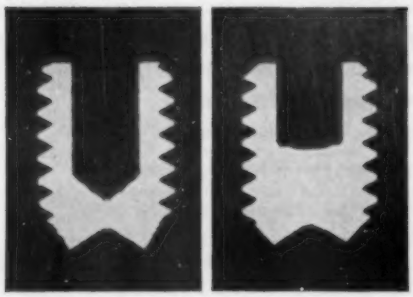
We fully form the threads—make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see in this illustration. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

UNBRAKO SET SCREW



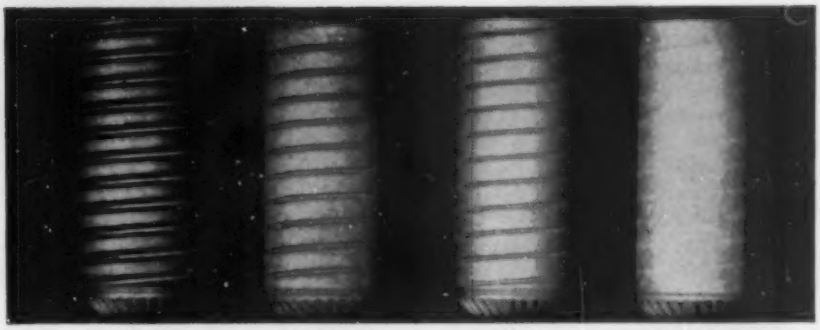
We put a radius in the socket corners—eliminate the sharp corners where cracks start. This distributes the stresses developed when tightening torques are applied. Ordinary socket screws have sharp corners which often crack when tightened even at lower recommended torques.

UNBRAKO SET SCREW **ORDINARY SET SCREW**

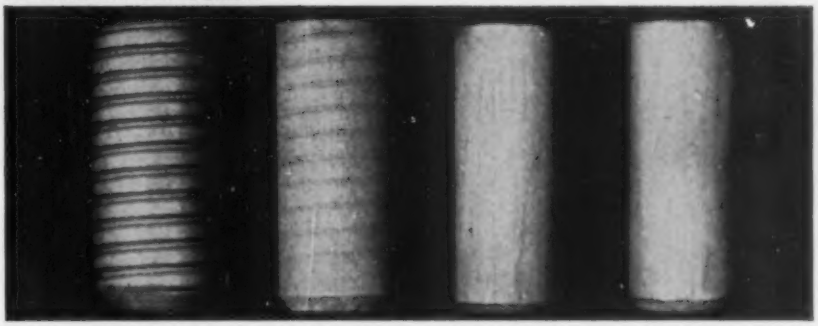


We form a deeper socket—give you more purchase with the wrench. Since more wrench can be put into the UNBRAKO socket, you can set the screw much tighter. And you won't ream the socket or round the corners of the wrench.

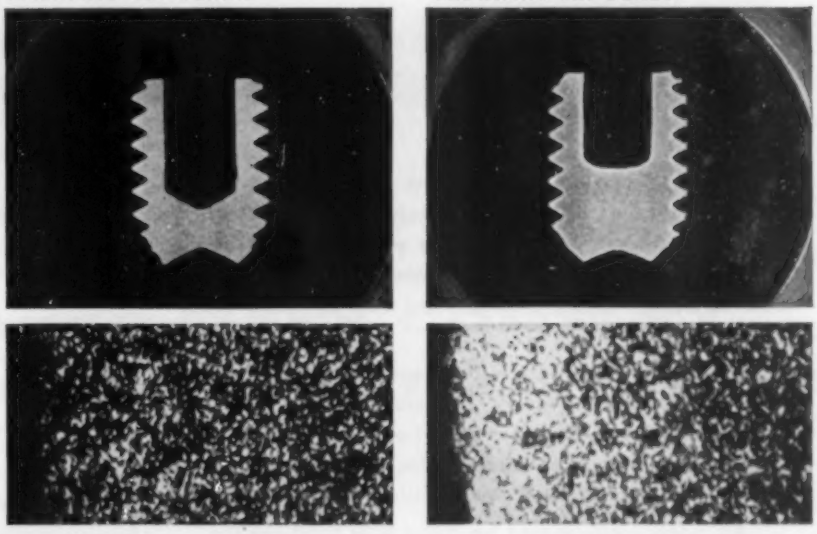
UNBRAKO SET SCREW



ORDINARY SET SCREW



UNBRAKO SET SCREW **ORDINARY SET SCREW**

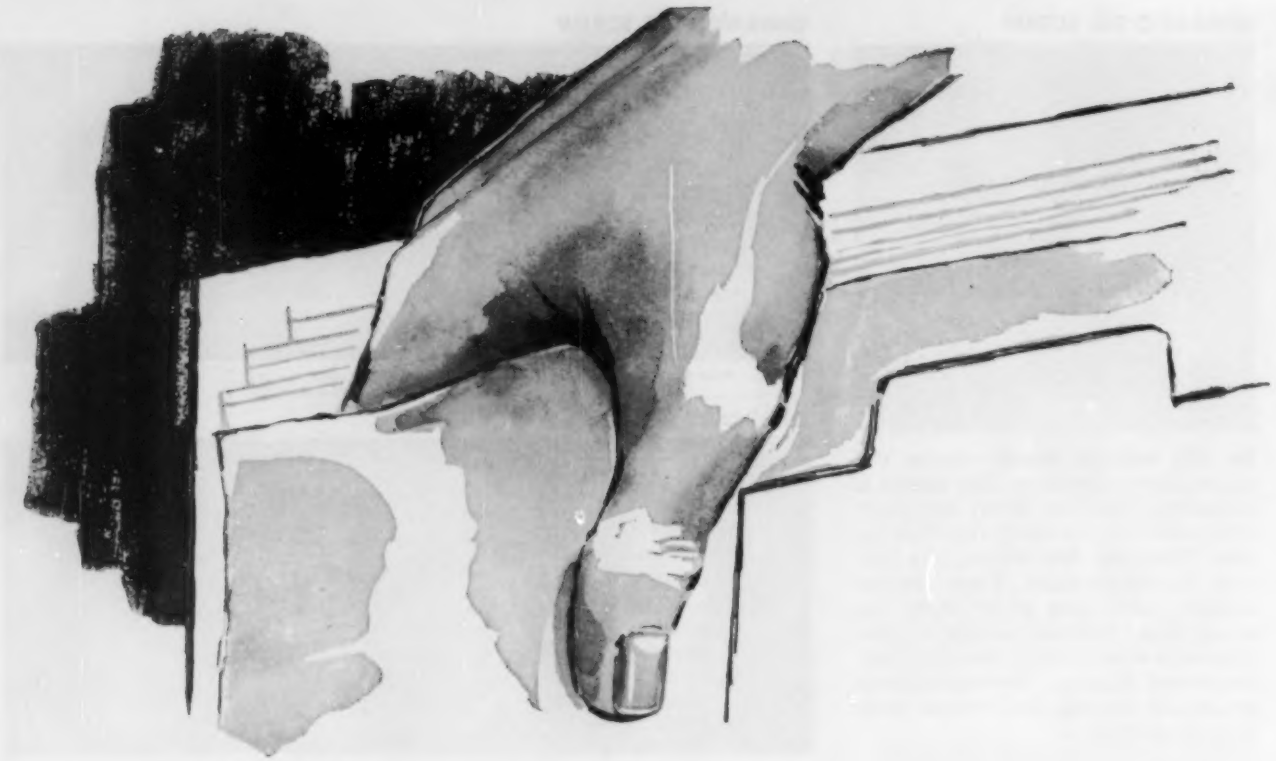


We heat treat an UNBRAKO properly. It's a ticklish job to heat treat a socket set screw. If you don't do it just right, you get decarburization. And decarb plays havoc with a screw. Put a wrench in the socket and you ream it. Run the screw into a tapped hole and you strip its threads. Try to seat the screw and its point shears off. These photos show the good and the bad. The UNBRAKO is clean. Its grain structure is uniform. There is no decarburization—the ordinary screw is suffering from an overdose of it, socket walls, threads and point are full of the telltale white spots.

You can't buy another set screw as good as an UNBRAKO. See your authorized industrial distributor today. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

Visit Booth 828 at the Production Engineering Show—
see the new UNBRAKO High-Torque Socket Set Screw demonstrated

UNBRAKO® SOCKET SCREW DIVISION SPS JENKINTOWN, PENNSYLVANIA

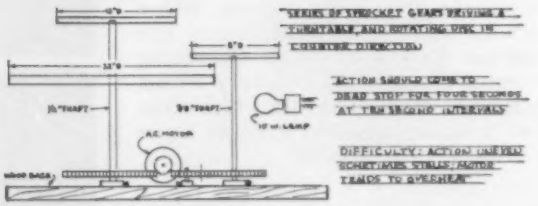


filed . . . . because you could not find a motor of correct specifications to power your brain child

You are sure your idea is sound. You have checked every phase of its operation on paper. Your mock-up looked sensational. Yet the motors you tried were not satisfactory. The machine did not come up to expectations. You put it aside, hoping some day to locate the trouble.

The answer . . . may be in the gearing, the bearings, the load, the motor speed, the motor torque rating . . . or an excess power demand that could be solved by simple redesign to reduce friction and restore balance.

All good ideas should be given a second chance. Take that "should-have-worked" idea out of your file. And if you believe it failed because of an inadequate power unit, give us the facts. Just draw a simple diagram, like this:



Give this information to your local SYNCHRON Representative, or mail it to the factory. Your particular problem will be referred to our carefully guarded research department for confidential analysis and reply.

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Electric Motor Engr., Inc., 8255 Beverly Blvd., Los Angeles, Cal.
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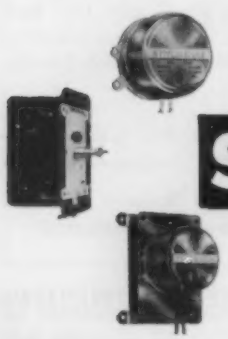
Cable-Hight Co., 1900 Euclid Ave., Cleveland, Ohio



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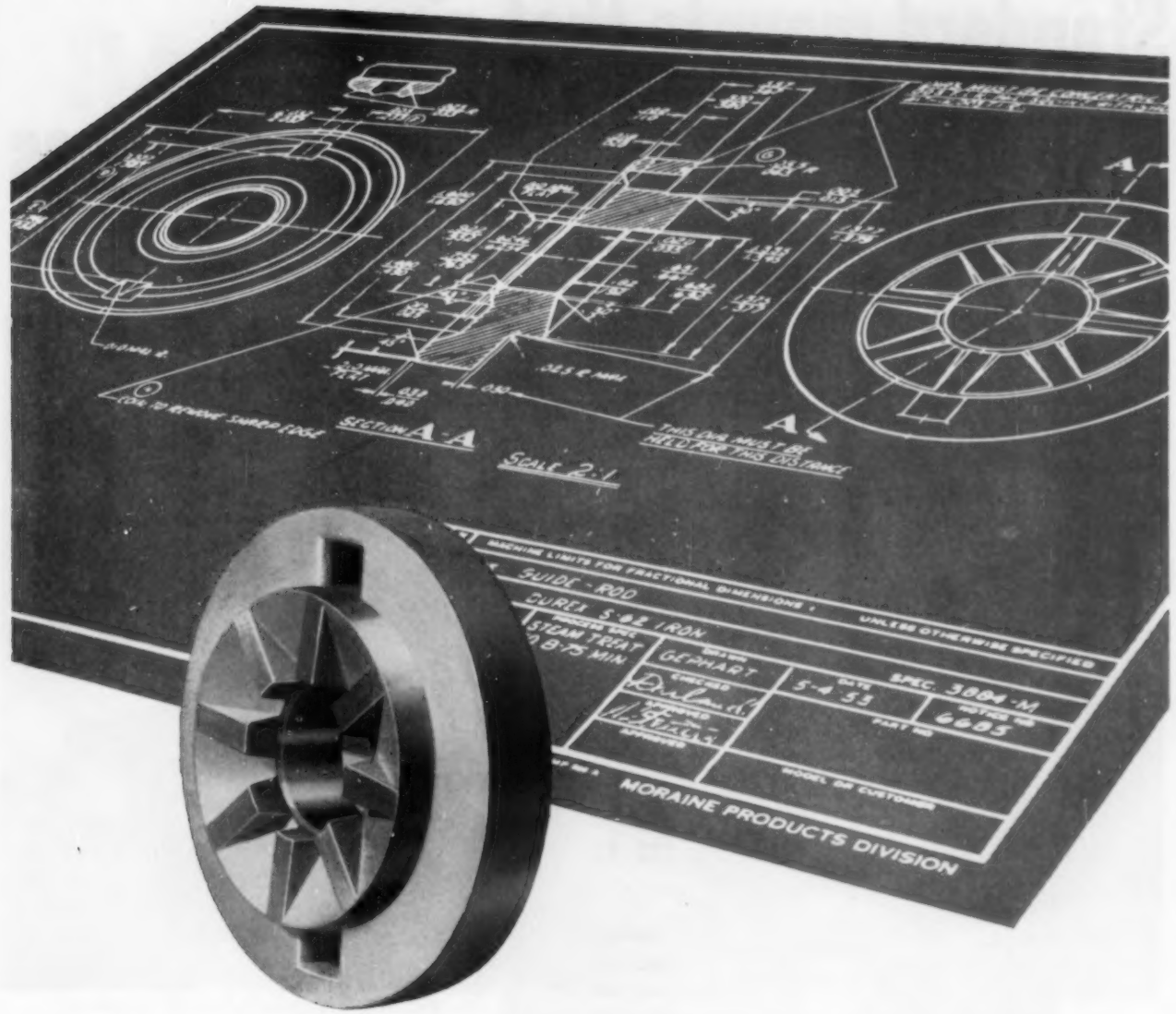
SYNCHRON SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, AND MAGNA-TORC D.C. MOTORS

HANSEN MANUFACTURING CO., INC. PRINCETON 5, INDIANA

Established 1907



MORAINE MAKES MANY COMPLEX PARTS FROM METAL POWDER

When you examine the background print you note the intricate design and close tolerances demanded of this metal powder part. Imagine the expense entailed in producing this part by conventional casting and machining methods!

Through the use of Moraine metal powder technique, this part is produced to precision standards with *one* press operation. The savings in cost make a most important contribution to the over-all profit possibilities of products using similar parts.

This is but one more example of what is being accomplished through cooperative effort between customer and Moraine. Industries everywhere are improving performance and cutting costs by sharing Moraine's experience with metal powder.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

METAL POWDER PARTS

Standard mounts that give vibration isolation in the special class

• With Isomode Type 5 isolators, you get an unusual degree of isolation efficiency. They offer equal spring rates in all directions. This means better control of all modes of motion.

Other special advantages of Isomode Mounts: In addition to absorbing equally well troublesome vertical, horizontal and rocking motions, they can be installed at any angle, thereby simplifying design of the suspension. They offer high load capacity in compact sizes. They have plenty of rubber for vibration-absorbing softness . . . yet are stable and self snubbing against shock loads.

These features make Isomode standard mounts suitable for a wide variety of special applications. In the photo above, you see them in an underfloor bus engine suspension. You'll also find these heavy duty mounts in trucks, motor-generator sets, aircraft oil tanks, compressors . . . to name a few.

As a principal source for special-performance mounts available as standard units, MB may have the answer to *your* vibration problem. Contact us and see.

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BULLETIN NO. 616 gives useful and helpful data on vibration. Send for your copy of our latest revision.

the MB *manufacturing company, inc.*

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HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT

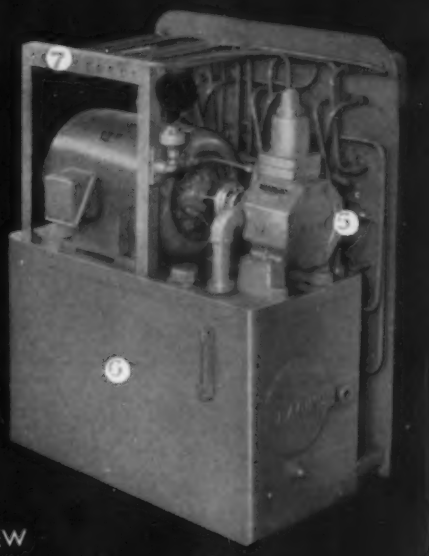
RACINE

HYDRAULIC POWER PLANTS

A RACINE packaged Power Unit offers you maximum flexibility in operation and performance. It comes complete, ready for immediate installation on your equipment.

The heart of this system, a RACINE Variable Volume Pump, conserves horsepower by putting all of the oil to work. Relief and By-pass Valves with extra piping are unnecessary. On this unit all control valves are neatly tubed to a terminal block from which connections are made to the machine.

FRONT VIEW



REAR VIEW

DESIGNED FOR YOUR NEEDS

These package units can be designed to meet your space and circuit requirements. All components are centrally located with the Control Valves positioned on an easily accessible control panel. Investigate the possibilities as applied to your products. Write for complete RACINE Hydraulic Catalog and the name of your nearest RACINE Field Office offering a complete engineering service.

KEY TO PARTS

1. RACINE FEED VALVE
2. RACINE DIRECT SOLENOID OPERATED 2-WAY VALVE
3. RACINE DIRECT SOLENOID OPERATED 4-WAY VALVE
4. GLOBE SHUT-OFF VALVE
5. RACINE VARIABLE VOLUME PUMP
6. RACINE OIL RESERVOIR
7. TERMINAL BLOCK

"They Work Better Together"

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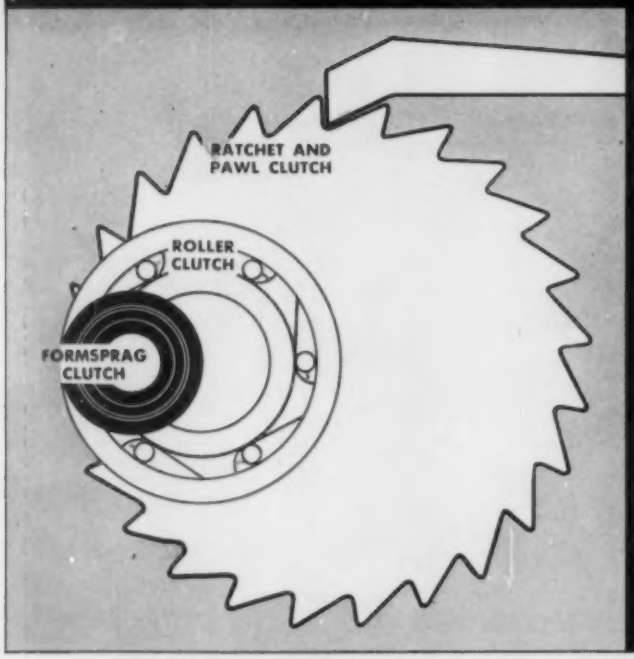
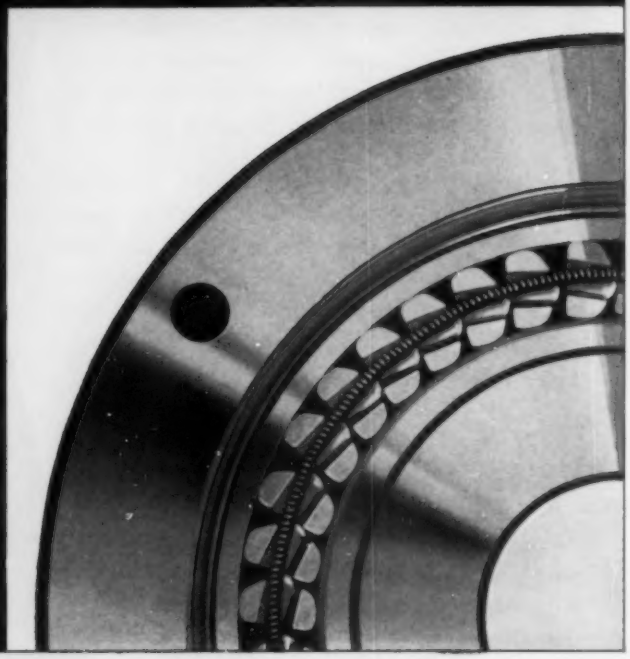
RACINE HYDRAULICS & MACHINERY, INC.
2072 Albert Street, Racine, Wisc., U. S. A.

How Formsprag's *Full Complement* Clutches Give *Better Performance* in all Over-Running, Backstopping, Indexing Applications





COMPARE IT WITH OTHER TYPES OF CLUTCHES—Note the size of each of the above types of clutches, yet each delivers approximately the same ultimate capacity. Not only does the Formsprag Clutch deliver more torque capacity for size and weight than any other type of over-running clutch, but you are also assured of longer life and greater accuracy through Formsprag's advanced design principles.

BASIC CONSTRUCTION SIMPLICITY—Torque is transmitted from one concentric race member to the other through a full complement of sprags. When torque is applied through the driving member, energizing springs instantaneously engage the sprags between driving and driven member. When torque is removed, all sprags instantaneously release.

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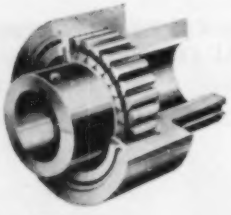
NO MEASURABLE BACKLASH. Instantaneous operation assures accurate and silent performance.

TREMENDOUS TORQUE CAPACITY—Unique, yet simple, full complement design provides more torque carrying capacity for size and weight than any other type of over-running clutch.

INTERNAL SIMPLICITY—There are only 4 basic parts: Outer Housing, Inner Race, Energizing Springs, Full Complement of Sprags.

LONG LIFE—Infinite number of gripping positions provides low unit stress at changing contact points.



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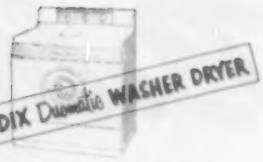
VAN DYKE, MICHIGAN

these famous names

FASTEN IT *and* FORGET IT *with* Everlock®

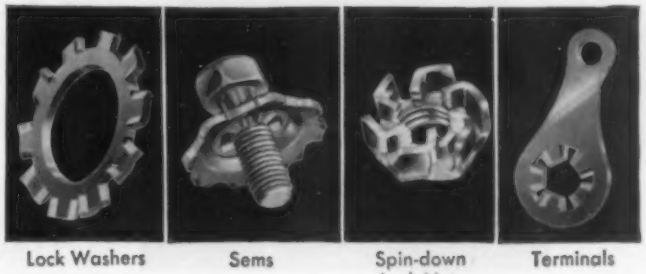
INDUSTRIAL FASTENERS



Vibration, twisting, impact—when you fasten it with EVERLOCK lock washers you can *forget* all these enemies of your product. That's because EVERLOCK lock washers are different—have alternating *chisel edges* that bite into the face of both work and screw under powerful spring tension. *They just won't let go.*

EVERLOCK lock washers are available in standard types or to your own specifications. Ask us about them now—so that next time you order lock fasteners you'll be in a position to specify EVERLOCK. More and more quality manufacturers do.

THOMPSON-BREMER & CO.
516 N. Dearborn Street, Chicago 10, Ill.
Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY, New York



Lock Washers | Sems | Spin-down Lock Nuts | Terminals

GET PROMPT SERVICE FROM YOUR LOCAL Everlock REPRESENTATIVE

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INDUSTRIAL FASTENERS

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Comprehensive, complete. Your "bible" for the best in lock fasteners. Mail the coupon for your free copy.

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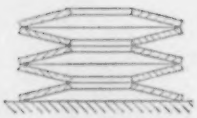
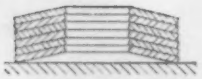
Belleville Spring Washers

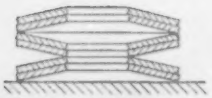
Solve Spring problems of HIGH LOADS in a limited space



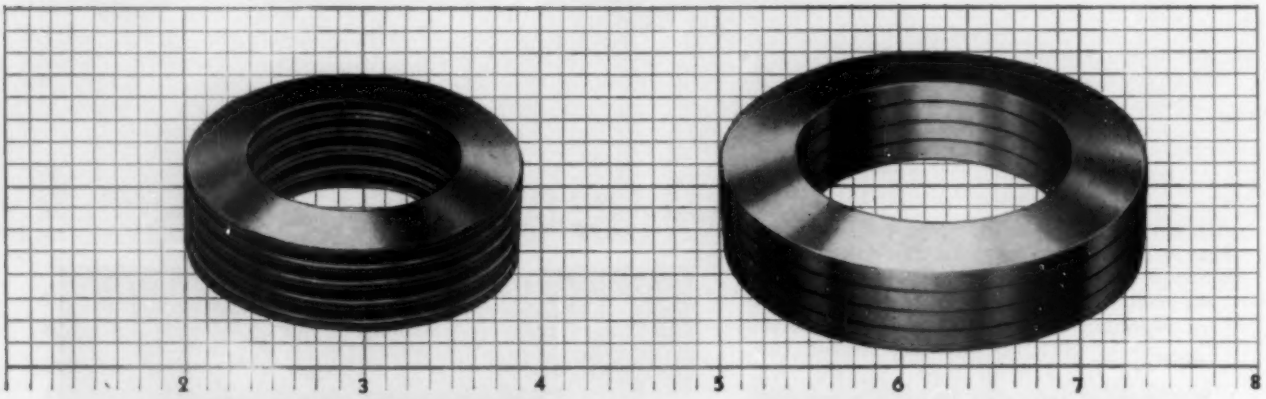
IN SERIES



IN PARALLEL



IN PARALLEL-SERIES



.025 THICK STEEL
10 WASHERS IN SERIES
35 LBS. AT .250 DEFLECTION

.125 THICK STEEL
4 WASHERS IN PARALLEL
8000 LBS. AT .025 DEFLECTION

Adaptable to a wide variety of loads and deflections

Send for Belleville Spring Washer Pamphlet

Wallace Barnes COMPANY

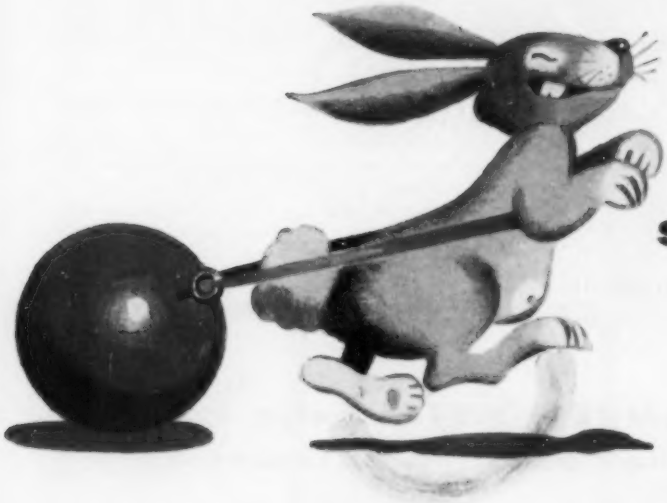
DIVISION OF ASSOCIATED SPRING CORPORATION

BRISTOL, CONNECTICUT

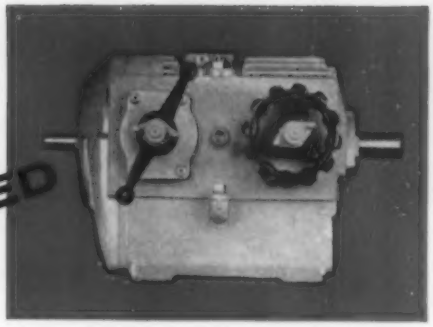
and SYRACUSE 9 (Solvay), NEW YORK

some need it FAST

some need it SLOW



some need VARIABLE SPEED



to make production flow

. . . chances are, if you're playing tortoise and hare on your production line, you're trying to put a rocket on the turtle and a ball and chain on the hare. Why not inquire about the new GEROTOR transmission and its application to your problem. GEROTOR would welcome the opportunity to tackle your problems on variable speed and show you how a GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION can solve those problems . . . and many, many more. *Why not write today?*

MANUFACTURERS OF

GEROTOR

MAY CORPORATION

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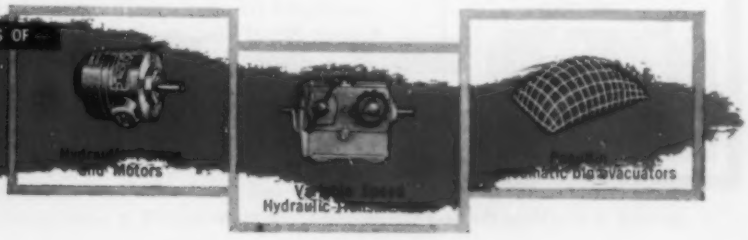
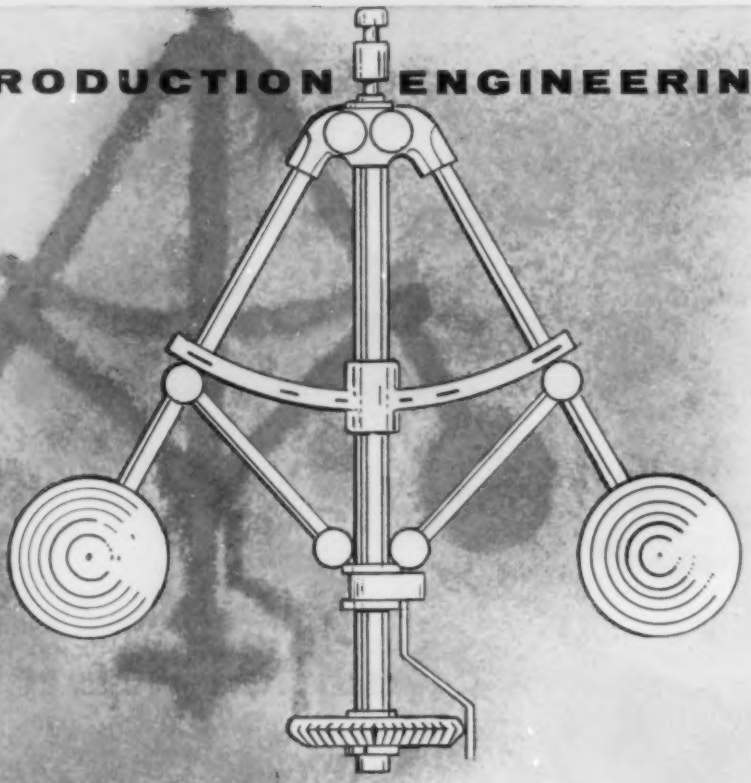


PRODUCTION ENGINEERING SHOW



AMPCO* METAL helps keep the "auto" in automation

. . . resists wear, corrosion and other forces that shorten machine life — to keep your production rolling

A breakdown on an automated production line means expensive delays. That's why critical parts made from Ampco Metal pay their small cost many times over.

Ampco Metal is often called "The Metal Without An Equal" — and for good reason. This remarkable series of special copper-base alloys stand up to most destructive forces that reduce machine life, halt production.

For instance, Ampco has outlasted steel as much as 60 times in applications where severe sliding wear and heavy shock loads are present. It's a remarkable bearing material — especially when used against hardened steels. Gears, bushings, wear strips, etc. have operated for years without visible wear. It retains mechanical values under conditions of high temperature or extreme cold. It reduces sound and vibration. And its high strength-to-weight ratios permit the use of lighter sections that are strong.

What's more, Ampco Metal is available in any form you need and can be machined to your specifications in our modern Machine Shop. Think of Ampco Metal, Inc. as a "one-source" supplier from raw materials to finished products.

Get the full story on this unique engineering material at the Production Engineering Show or write us for complete information.

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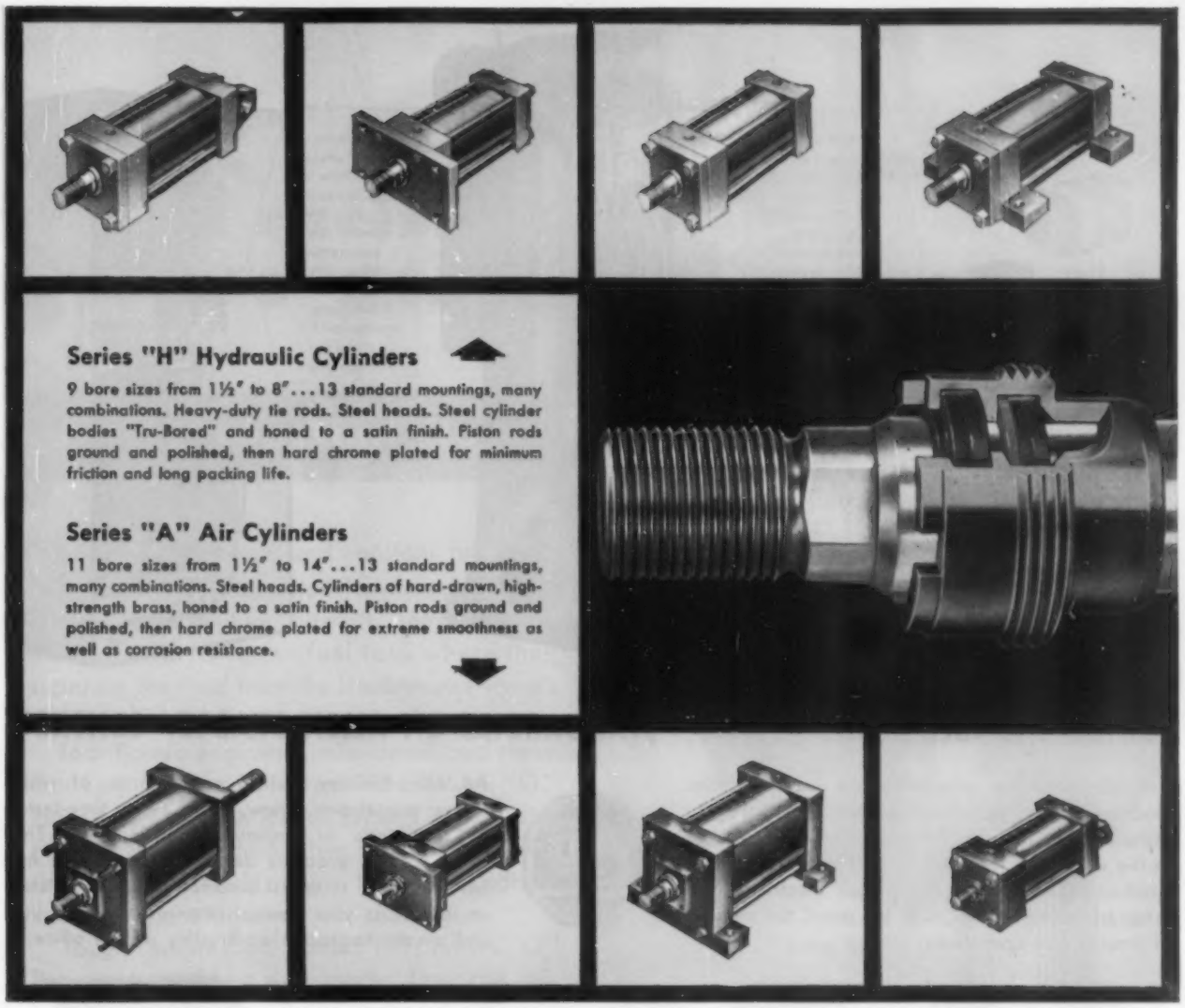
Sole Producer of Genuine Ampco Metal



Series "H" Hydraulic Cylinders

9 bore sizes from 1½" to 8"...13 standard mountings, many combinations. Heavy-duty tie rods. Steel heads. Steel cylinder bodies "Tru-Bored" and honed to a satin finish. Piston rods ground and polished, then hard chrome plated for minimum friction and long packing life.

Series "A" Air Cylinders

11 bore sizes from 1½" to 14"...13 standard mountings, many combinations. Steel heads. Cylinders of hard-drawn, high-strength brass, honed to a satin finish. Piston rods ground and polished, then hard chrome plated for extreme smoothness as well as corrosion resistance.

Only HANNIFIN Square-Type Cylinders Have This Revolutionary New Gland

The gland you see here represents the biggest improvement in cylinder design in the last 50 years. And, you'll find this gland only in Hannifin Square-Type Air and Hydraulic Cylinders.

This exclusive Hannifin Gland is a bronze cartridge, *externally removable and replaceable as a unit* to meet J.I.C. recommendations. The packing is new, too. Outside is the "Wiperseal." It serves a dual purpose as it *wipes both ways* to provide a dry rod on the out-stroke, a dirt-free rod on the in-stroke. Inside is the "Lipseal"...self-compensating, self-relieving and nonadjustable. It provides an efficient seal throughout its long life.

Find out how easily you can apply Hannifin Cylinders to your requirements. They're available for prompt delivery—in all sizes and all standard mounting styles—and at competitive prices despite all their exclusive features.

WRITE FOR BULLETINS

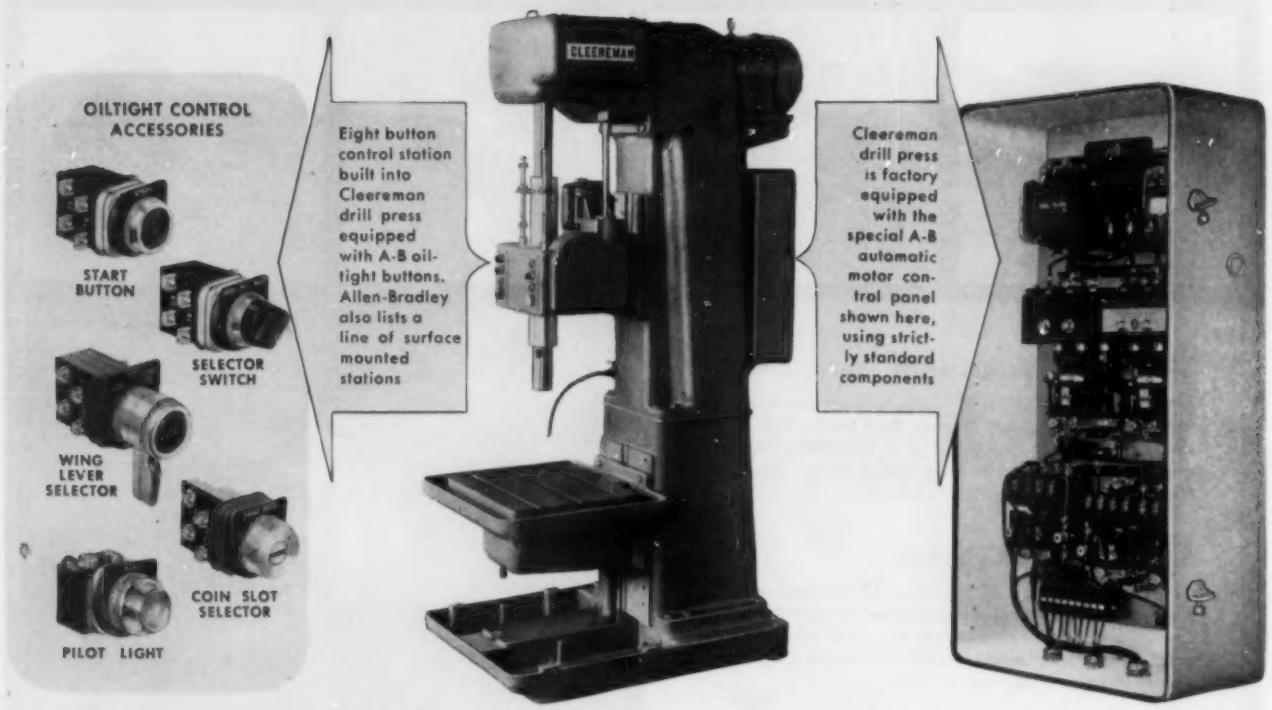
Bulletin 113. Series "H" Hydraulic Cylinders

Bulletin 213. Series "A" Air Cylinders

HANNIFIN

Hannifin Corporation, 525 S. Wolf Rd., Des Plaines, Ill.

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

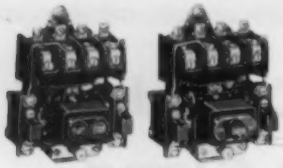

OILTIGHT CONTROL ACCESSORIES
START BUTTON
SELECTOR SWITCH
WING LEVER SELECTOR
COIN SLOT SELECTOR
PILOT LIGHT
Eight button control station built into Cleereman drill press equipped with A-B oil-tight buttons. Allen-Bradley also lists a line of surface mounted stations
CLEEREMAN
Cleereman drill press is factory equipped with the special A-B automatic motor control panel shown here, using strictly standard components

FOR DEPENDABLE AUTOMATION • • STANDARDIZE ON ALLEN-BRADLEY CONTROLS

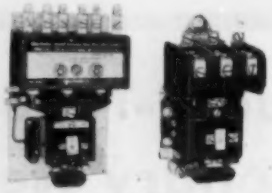
Control panels for an automation line of special machinery must be ultradependable to make the installation a success. The failure of a single item in the control sequence may shut down the entire production line. That is why all electrical and magnetic components must be good for *millions* of *trouble free operations*.

A-B Quality

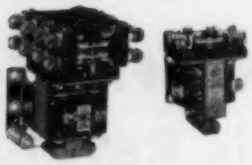
All Allen-Bradley control components, of which a few are shown below, have been time-tested in thousands of industrial applications. They are QUALITY products designed for trouble free service in the toughest automation layouts. Permit us to discuss your control requirements with you. Call on the nearest Allen-Bradley district office.



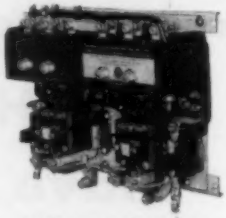
SOLENOID STARTERS
With push buttons • with selector
The Form 2 construction is for remote control



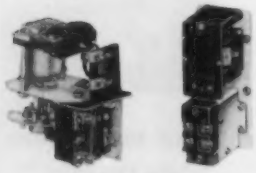
CONTACTORS
From one to eight poles
Ratings up to 1000 amps



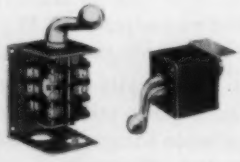
SOLENOID RELAYS
In a wide variety of types



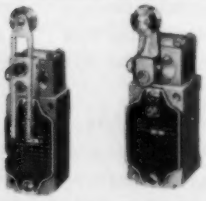
REVERSING STARTERS
Up to 600 hp, 440-550 v



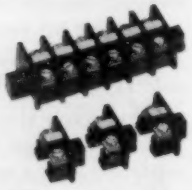
TIMERS
Motor-driven • pneumatic
Other types available



DRUM CONTROLLERS
Up to 500 hp, 440-550 v



OILTIGHT LIMIT SWITCHES
A complete line



TERMINAL BLOCKS
Interlocking to any length

Allen-Bradley Co.
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Milwaukee 4, Wis.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

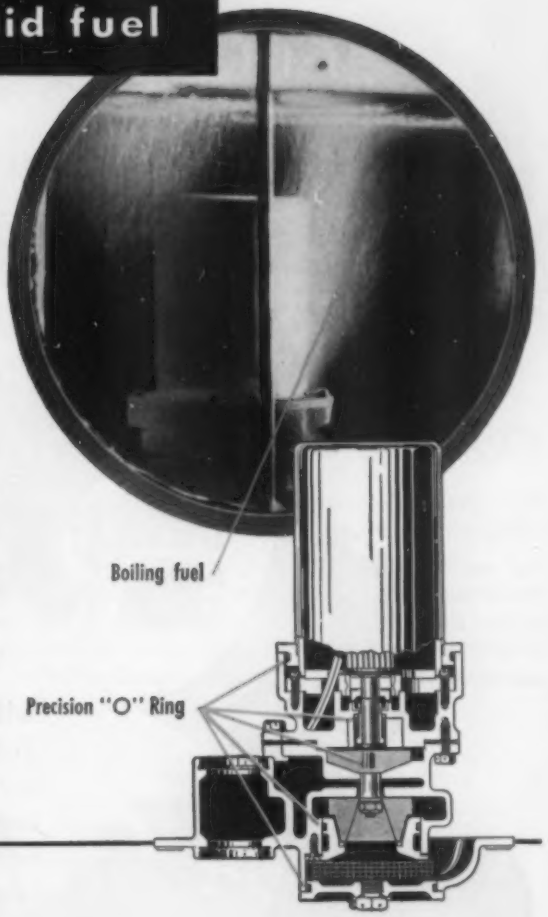
Precision "O" Rings

insure constant flow of liquid fuel

To provide positive and constant fuel flow, Lear-Romec centrifugal booster pumps are used in many high altitude aircraft. They are submerged directly in the fuel tank where they separate the fluid from the troublesome vapors which are formed at higher altitudes.

Lear-Romec engineers, who developed these amazing pumps, selected PRECISION "O" Rings for the tough job of sealing the booster pump from these destructive fuel vapors. Now, thanks to PRECISION quality, fuel vapors cannot interrupt operation and "kill" the engine.

Tough compression-molded PRECISION "O" Rings are the finest ever made. They are universally used for the toughest vapor and liquid sealing jobs in hydraulic mechanisms, control valves, couplings and hundreds of other assemblies. Why not put PRECISION in your plans?



FREE — Write for your personal copy of our Handbook on "O" Rings

Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal® Specialists

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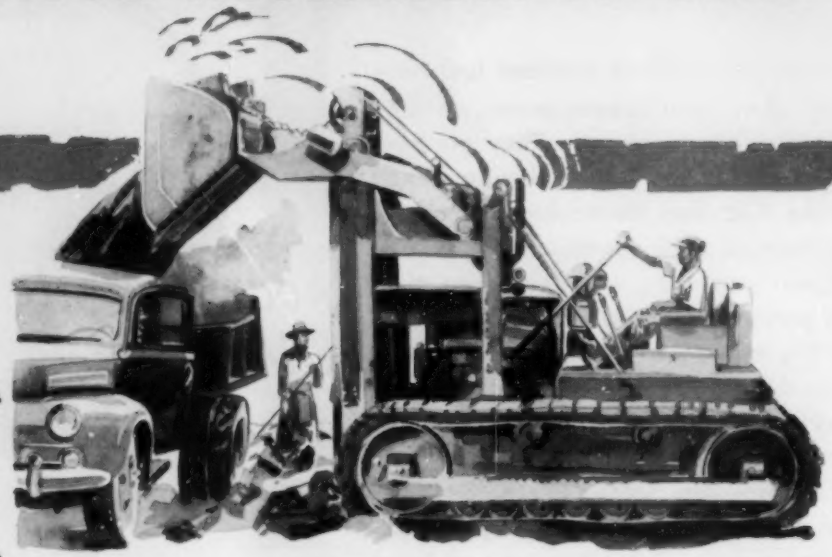
Canadian Plant at: Ste. Therese de Blainville, Quebec

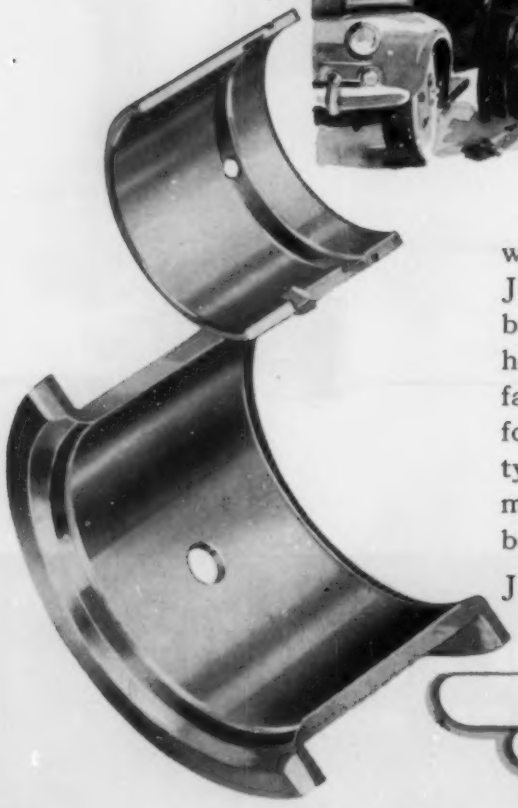
HEAVY DUTY
EQUIPMENT REQUIRES

Rugged

BEARINGS —

JOHNSON ALUMINUM-ON-STEEL





Here are sleeve bearings which will easily handle loads up to 5000 P.S.I. Johnson Aluminum-on-Steel Bearings are built for heavy equipment, high speeds, and heavy loads. In this service, equipment manufacturers report exceptionally satisfactory performance, much better than with other bearing types. Month after month they are becoming more generally recognized as the preferred bearings in many heavy duty engines . . .

JOHNSON BRONZE COMPANY
508 South Mill Street, New Castle, Pa.

JOHNSON JB BEARINGS
Sleeve-Type

Johnson Bronze Produces All Types of Sleeve Bearings: ALUMINUM-ON-STEEL • CAST ALUMINUM ALLOY • BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • LEDALOYL powder metallurgy • POWDERED IRON

PHOTO COURTESY YALE MATERIALS HANDLING DIVISION, THE YALE & TOWNE MANUFACTURING COMPANY, PHILADELPHIA, PA.

...down go costs with modern fork lift trucks powered and protected by Chrysler Power Partners

Costs come down when a modern fork lift truck is on the job. That's because these little giants will tackle anything around the plant or warehouse—unload, carry, stack and load it faster, safer and save space and personnel doing it.

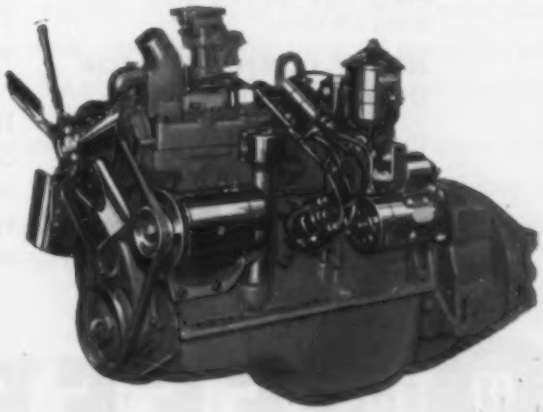
It's a fact. Modern fork lift trucks, like the highly regarded Yale Industrial Lift Trucks pictured here, have been credited with savings up to 50% in handling costs. Yale 51 Series Gas Trucks in ranges from 3,000 to 10,000 pounds capacity are all Chrysler-powered. Here, hard at work in a midwest building supply company warehouse, are two 4,000 pound capacity Yard Kings. They are stacking cement and roofing materials in tiers so as to take greatest advantage of every inch of valuable space.

Chrysler Ind. 30 230 cubic inch displacement six-cylinder engines power these units. All power impulses are transmitted through Chrysler gyrol Fluid Coupling, not only enabling oil-smooth, easy-to-learn, easy-to-handle operation, but also extending clutch life and cushioning engine and transmission from shock loads.

In materials handling equipment or any equipment requiring lightweight, high-speed industrial power in compact, easily-installed engines, you can depend upon Chrysler Industrial Engines—230 to 413 cubic inch displacement. For added adaptability each can be factory-equipped for gasoline or LPG operation. You may also specify Chrysler gyrol Fluid Coupling factory installed.

Remember too, Chrysler Industrial Engines are not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. See a Chrysler Industrial Engine Dealer or write: ***Dept. 69, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

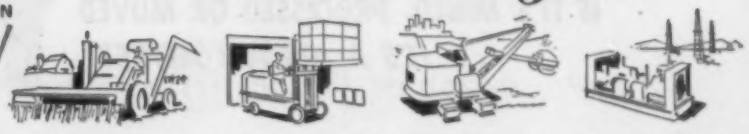
CHRYSLER INDUSTRIAL 30 ENGINE
230 CUBIC INCH DISPLACEMENT



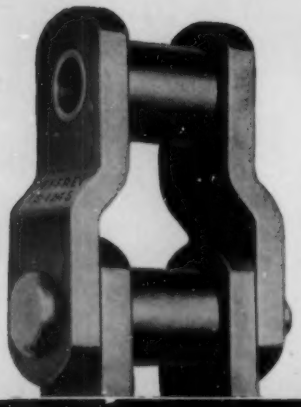
CHRYSLER *Industrial Engines*

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER WITH A PEDIGREE

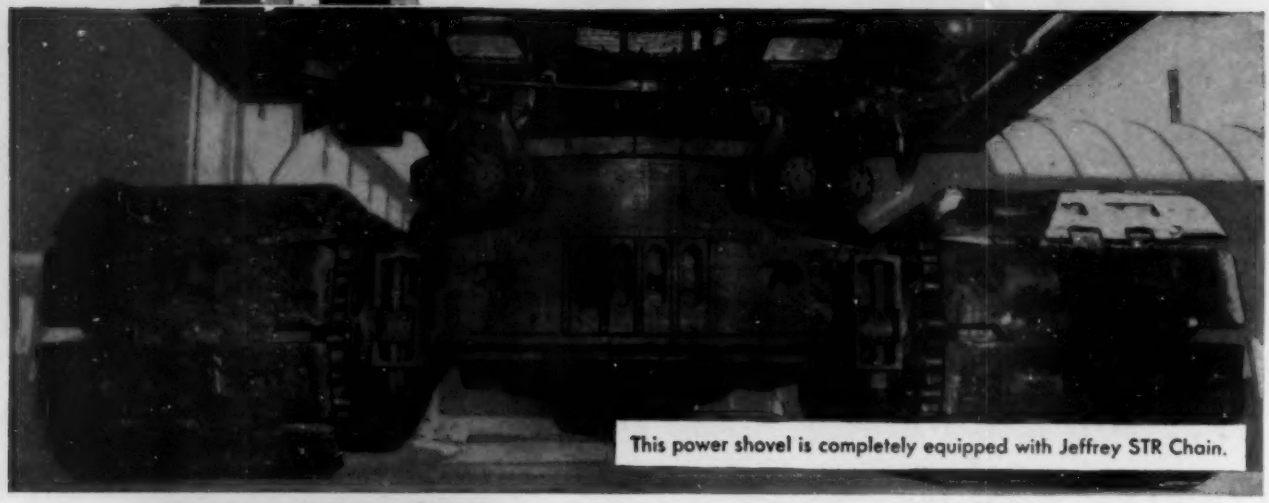


AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS

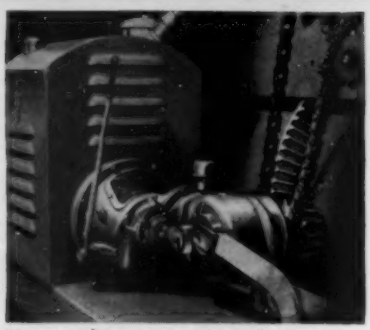


Engineers' choice:

JEFFREY drive chain quality makes good equipment better



This power shovel is completely equipped with Jeffrey STR Chain.



Heavy duty concrete mixer uses Jeffrey STR Chain.

JEFFREY COMPONENTS FOR ORIGINAL EQUIPMENT:

- STR DRIVE CHAINS
- STEEL CARVE SPROCKETS
- HOLLOW PIN CHAINS
- CAST IRON SPROCKETS
- STEEL KNUCKLE CHAINS
- BABBITTED PILLOW BLOCKS
- COMBINATION CHAINS
- SPIRAL CONVEYORS

Equipment manufacturers from coast to coast rely on Jeffrey STR chain for flexible transmission of power in large and small unit machines such as power shovels, draglines, road pavers, ditchers, concrete mixers, garbage trucks, dredges and portable loading machines.

STR chain, in pitches of 1½" to 7", is ideal for drives on conveyors, elevators, machine tools, etc. Longer pitches, combined with attachments, are adapted to heavy duty elevating and conveying service.

If your equipment can use the superb quality of Jeffrey STR Drive Chain and Sprockets—you'll find they offer maximum strength for minimum weight, with ample reserve strength to permit normal wear and to withstand unexpected overloads.

THE JEFFREY MANUFACTURING CO.

ESTABLISHED 1877

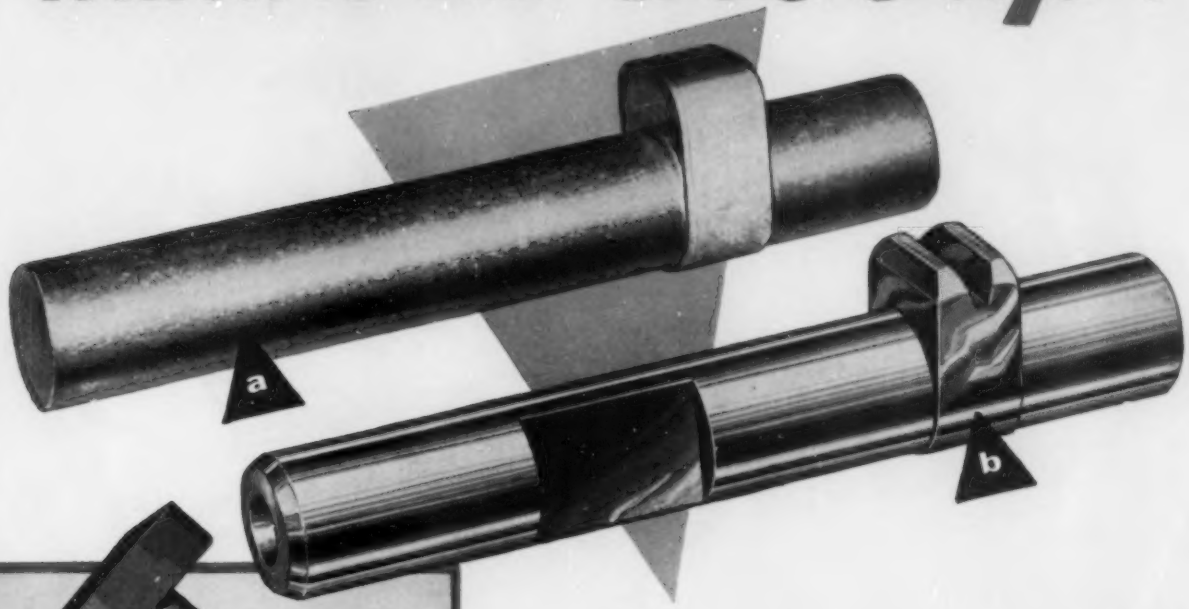
Columbus 16, Ohio

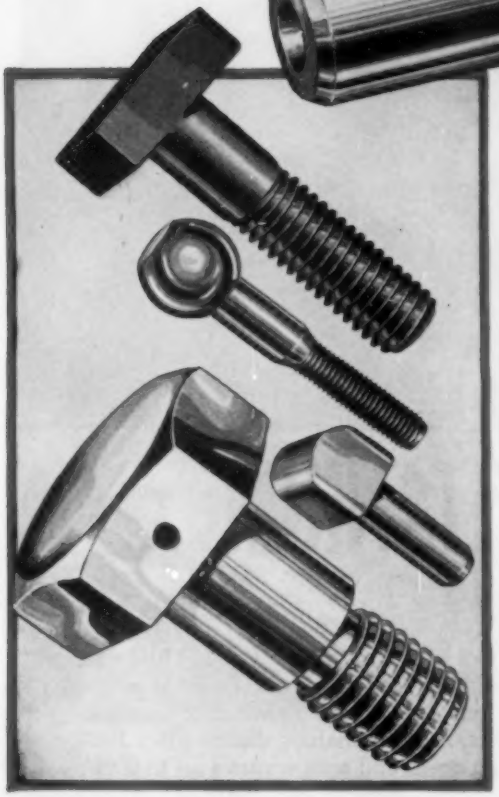
sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED
. . .IT'S A JOB FOR JEFFREY!

Which is the CleCap?





...it could be both _____ made by fast economical CleCap processes

It just might pay you to take a good look at the special parts you're buying that could be made more economically by CleCap's hot heading or cold extrusion processes. Quite a number of our customers have done it . . . and they like what happened.

The forged blank (a) above was produced for one user. He finished it as it's shown at (b). CleCap pre-forms your non-standard parts for further shaping and machining in your plant or manufactures them complete, ready for your assembly line. You'd be surprised at all the different shapes we've turned out.

You can save yourself tooling and machine time. Take a look at what CleCap offers—engineering skill and experience in applying high production methods and machines to your problems. Anyway, write for folder, "Specials by Specialists".

Cleveland *Top Quality* Fasteners

FERROUS AND NON-FERROUS

Hexagon Head Cap Screws • Socket Head Cap Screws—Plain & Knurled; also Flat and Button • Flat Head and Fillister Head Cap Screws • Place Bolts • Structural Bolts • Tractor Bolts • Square Head Set Screws • Socket Set Screws • Milled Studs

The Cleveland Cap Screw Co.

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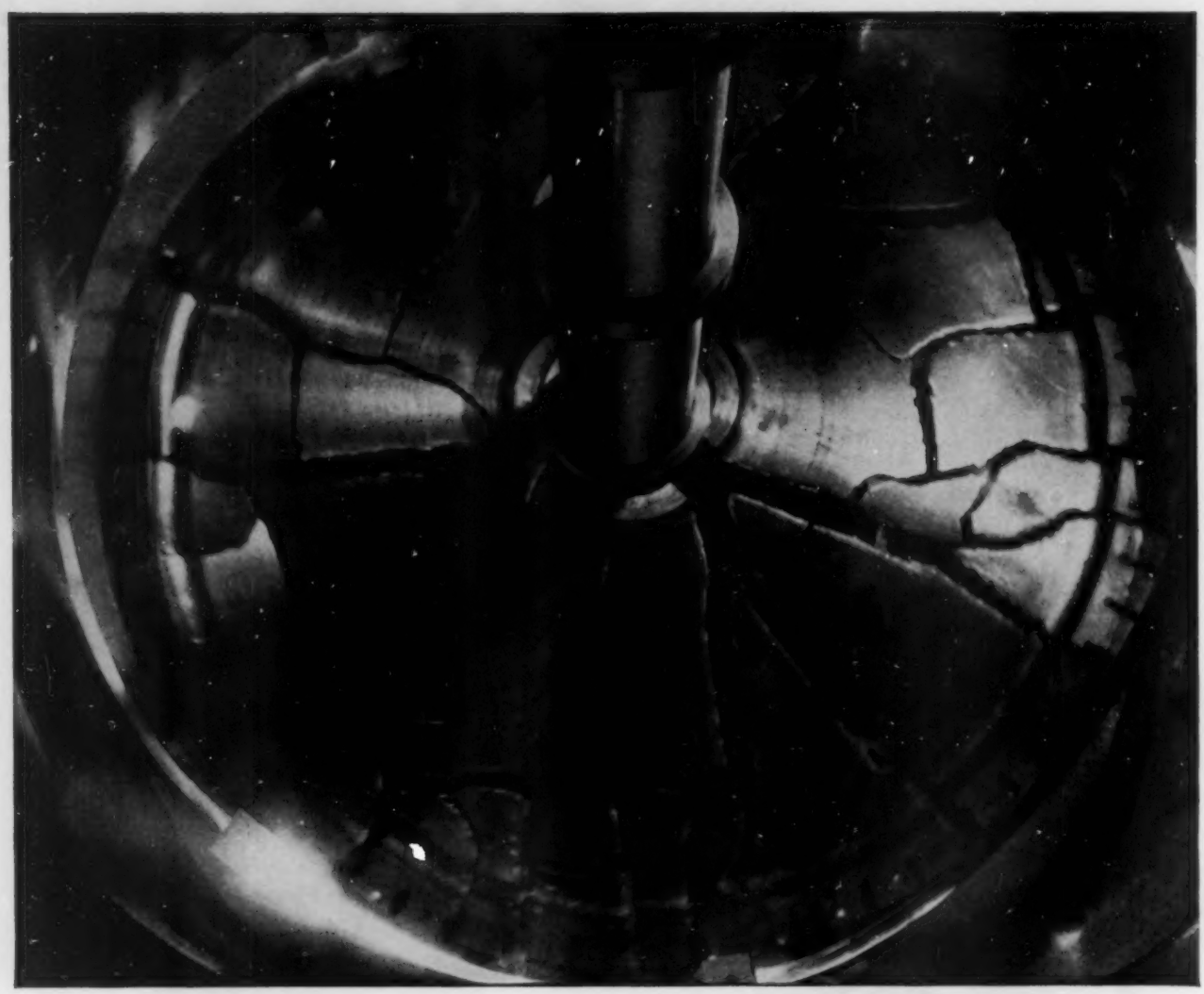
VUlcan 3-3700 TWX CV42

Originators of the Kaufman DOUBLE EXTRUSION Process



design it stronger with TITANIUM...

Engineers asked: "How strong and tough is titanium?" Here is one dramatic test which answered part of the question. The 18-pound Rem-Cru C-130AM titanium alloy jet compressor wheel shown, withstood more rpm's than the strongest steel. Engineers wanting to see how much it would take, finally had to notch it before it would break.

In other experiments, research engineers took titanium which had been in triple jeopardy from temperature, stress and salt water corrosion, and then tested to see how much more punishment it could take. Tests proved conclusively that there was no time limit on toughness for all grades of Rem-Cru titanium. For example, Rem-Cru A-70, stressed for five years (43,500 hours) at 80,000 psi, showed no loss in ductility. Rem-Cru C-110M and C-130AM high strength alloys also retained toughness under many severe combinations of temperature and stress. Both remained ductile after 1000 hours at high stress and temperatures up to 600F.

So if you're looking for a *strong, tough* metal, with light weight and exceptional corrosion resistance, REM-CRU titanium is the answer. And you are sure of an adequate supply of REM-CRU titanium, in most sizes and grades, due to REM-CRU's expanded facilities.

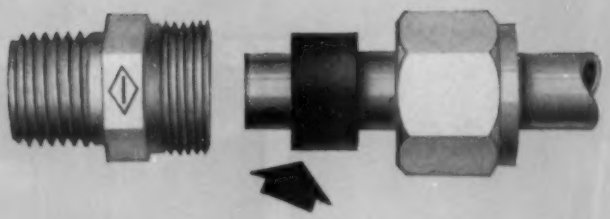
To keep abreast of the latest developments on this vital metal, write to Dept. PE-9 for the Rem-Cru Review—a free periodical presenting the latest technical data on titanium alloys.

REM-CRU TITANIUM

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

The Fitting that Never Gets Tired of Absorbing Shocks and Vibration!

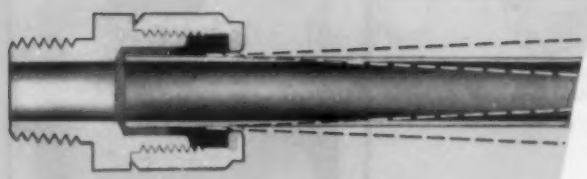
IMPERIAL FLEX FITTINGS ... Make Tube Fitting Failures Unnecessary



Every Flex Fitting embodies this vibration and shock absorbing sleeve.

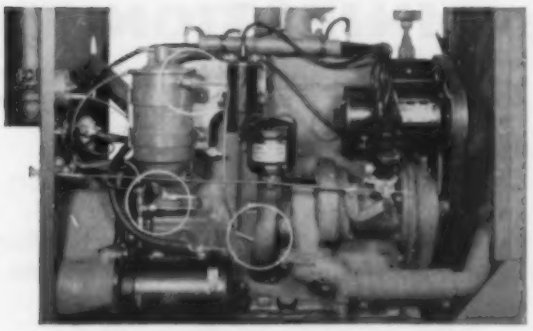
FLEX FITTINGS make safer joints that are virtually indestructible by vibration . . . absorb shock and minor tube movement . . . assure a positive pressure-tight seal.

FLEX FITTINGS are very easy to install . . . simply slip nut and Flex sleeve over tubing . . . insert tubing into body and tighten nut — that's all!

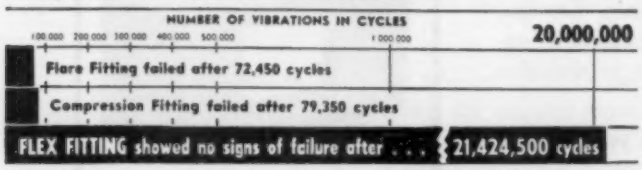


The Flex Fitting actually permits the tube to flex back and forth through angle shown. Note that tubing is cushioned against any damage.

FLEX FITTINGS can be used with all kinds of tubing



Comparative Vibration Test Results


NUMBER OF VIBRATIONS IN CYCLES
100,000 200,000 300,000 400,000 500,000 1,000,000
20,000,000
Flare Fitting failed after 72,450 cycles
Compression Fitting failed after 79,350 cycles
FLEX FITTING showed no signs of failure after . . . 21,424,500 cycles

On vibration tests, where other fittings failed quickly, Flex Fittings withstood over 20,000,000 cycles without sign of failure.

If you have a tough tubing connection job that involves vibration, shock or tube movement, it will pay you to consider IMPERIAL FLEX FITTINGS. Whether it's tractors, diesels, heavy power equipment, machinery or earth movers, you will be safe with FLEX FITTINGS. Thoroughly proved by extensive use.

Ask for Catalog 344

THE IMPERIAL BRASS MANUFACTURING COMPANY
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In Canada: 334 Lauder Ave., Toronto, Ontario

IMPERIAL

Pioneers in Tube Fittings and Tube Working Tools

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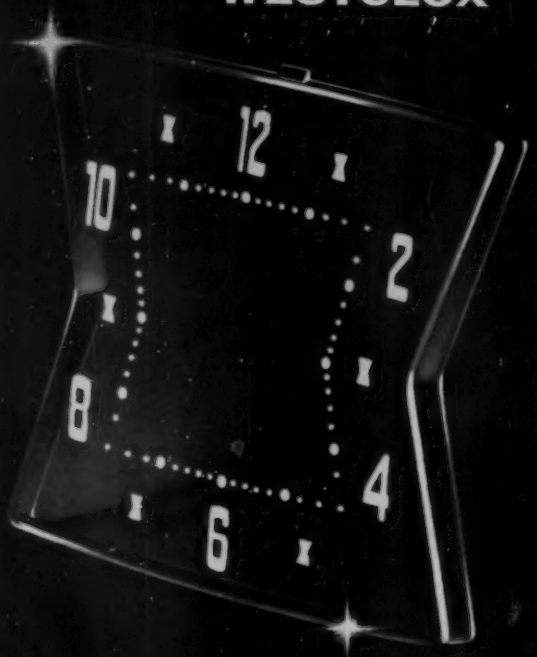
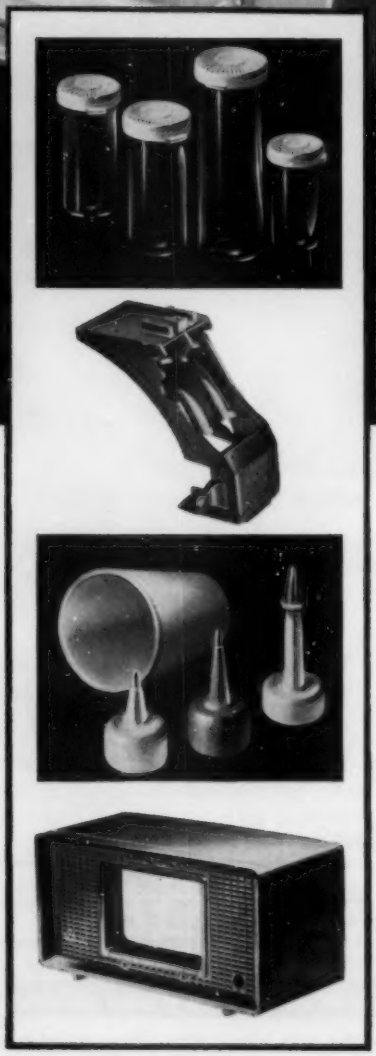
WESTCLOX



Westclox case (ZEST ELECTRIC WALL CLOCK) in gleaming white Styrene . . . custom-molded by Sylvania

beautifully executed by
SYLVANIA



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At Sylvania you get "one-source" custom-molding service in either thermoplastic or thermosetting materials. Design, die-making, metal stamping and forming, and complete assembly—these facilities offer the benefits of one production schedule, one delivery cycle, one responsibility.

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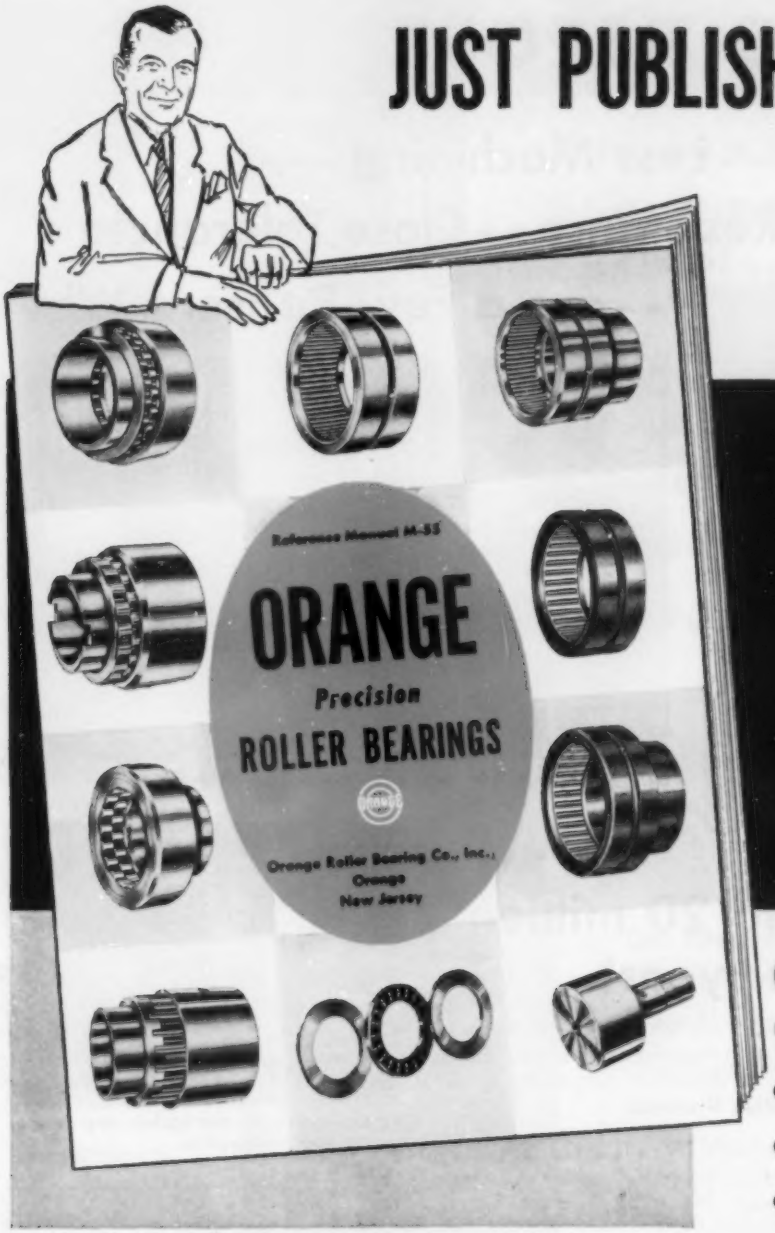

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DIE CASTING REPORT

Uniformity - - Less Machining - - - Corrosion Resistance - - Close Tolerances - - are a Few Reasons Why

This wringer-type Maytag washer has 24 die-cast parts.

Wringer parts include: gear case, cap and clutch pulley.

Maytag uses 15 to 20 million die cast parts per year!

Having produced over 9 million washing machines, no one knows better than Maytag Co. the importance of maintaining quality while meeting high production schedules. Die castings have helped solve the problem – at economical unit costs – by providing unlimited qualities of identical component parts. At the same time, aluminum and zinc die-castings have met the critical demands of functional applications. Examples of Maytag requirements. die castings must be (1) oil and water tight for gear cases and housings (2) true to dimension for line assembly with mating parts and (3) free and clear of external surface flaws.

While Maytag is a large user, those with lower requirements may enjoy similar economies and advantages. Let our creative design engineers look at your functional or decorative part needs, at no obligation of course.

For a copy of: "Die-Castings Unlimited." Address: Precision Castings Company, Inc., 199 Walnut Street, Fayetteville, N. Y.

Formerly sandcast, this washer cover is now an aluminum die-casting.

Small zinc die-cast components, mostly functional.

Switched to die castings from sand castings

Many of the die-cast parts in the Maytag automatic and wringer-type washer were formerly sandcast. Less machining, better surface quality, reduced finishing time are reasons for the changeover. Precision is one of the major die-casting suppliers to Maytag...and has been since 1938.

PRECISION CASTINGS CO., INC.

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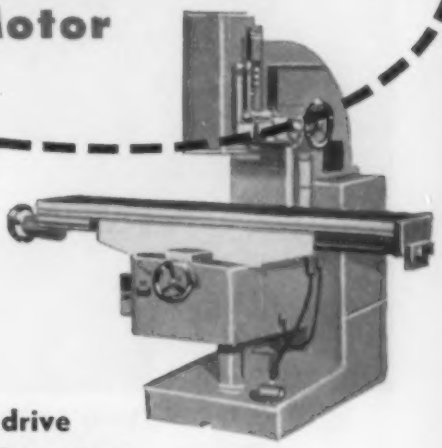
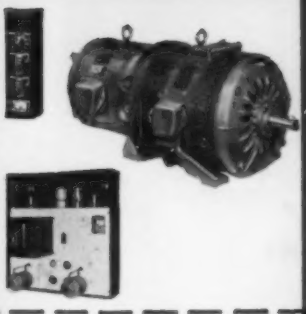
You can speed-up your machine-tool operation *when this button* operates a LOUIS ALLIS Adjustable Speed Drive or Special Motor



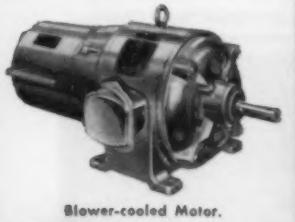


Ajusto-Spede® Drive

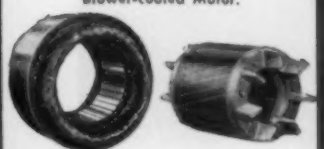
puts precision speed control at the operator's fingertips. ¾ to 75 hp. AC. Uses eddy current clutch to provide speed ranges up to 17:1. Tachometer feedback circuit offers precise speed regulation. Optional features available include dynamic braking, torque control, inching, jogging, multimotor operation and range drives.

Select-A-Spede Drive

5 to 200 hp. Magnetic amplifier and adjustable voltage control provides superior speed regulation from ⅛ base speed to full speed. Optional control features include reversing, dynamic braking, jogging, special programming or sequencing, extra wide speed range. Electronic and Static Select-A-Spede Drives also available in smaller horsepower ranges. Speed regulation to ½% in ranges up to 100:1. All operate from AC source.



Blower-cooled Motor.



Rolled-shell, Shaftless Motor.

Special Motors

You don't have to compromise — or take a unit that "almost" does your job when you choose Louis Allis. On short notice you can get a unit exactly engineered and designed for your job. Some of the special characteristics built into Louis Allis motors for specialized machine-tool use include high starting torque, high slip, multi-speed operation, and rapid reversing. Other special features may include precision balance, high-frequency operation, and special-duty cycles. For these or any other special electrical or mechanical modification for machine tool work, see Louis Allis first.

Get the precision drive your machine tool requires from the *complete* Louis Allis Line

New precision machine tools call for precision drives. That's where Louis Allis fits into *your* picture. Louis Allis has the exact unit you need because it has the most complete line of motors and drives available to industry.

And if one of Louis Allis's wide range of stock motors doesn't exactly fit your job's requirements, you can get prompt delivery on a unit specially designed to give you the electrical or mechanical characteristics you need. Call your nearby Louis Allis Sales Engineer for motor application assistance on your problem.

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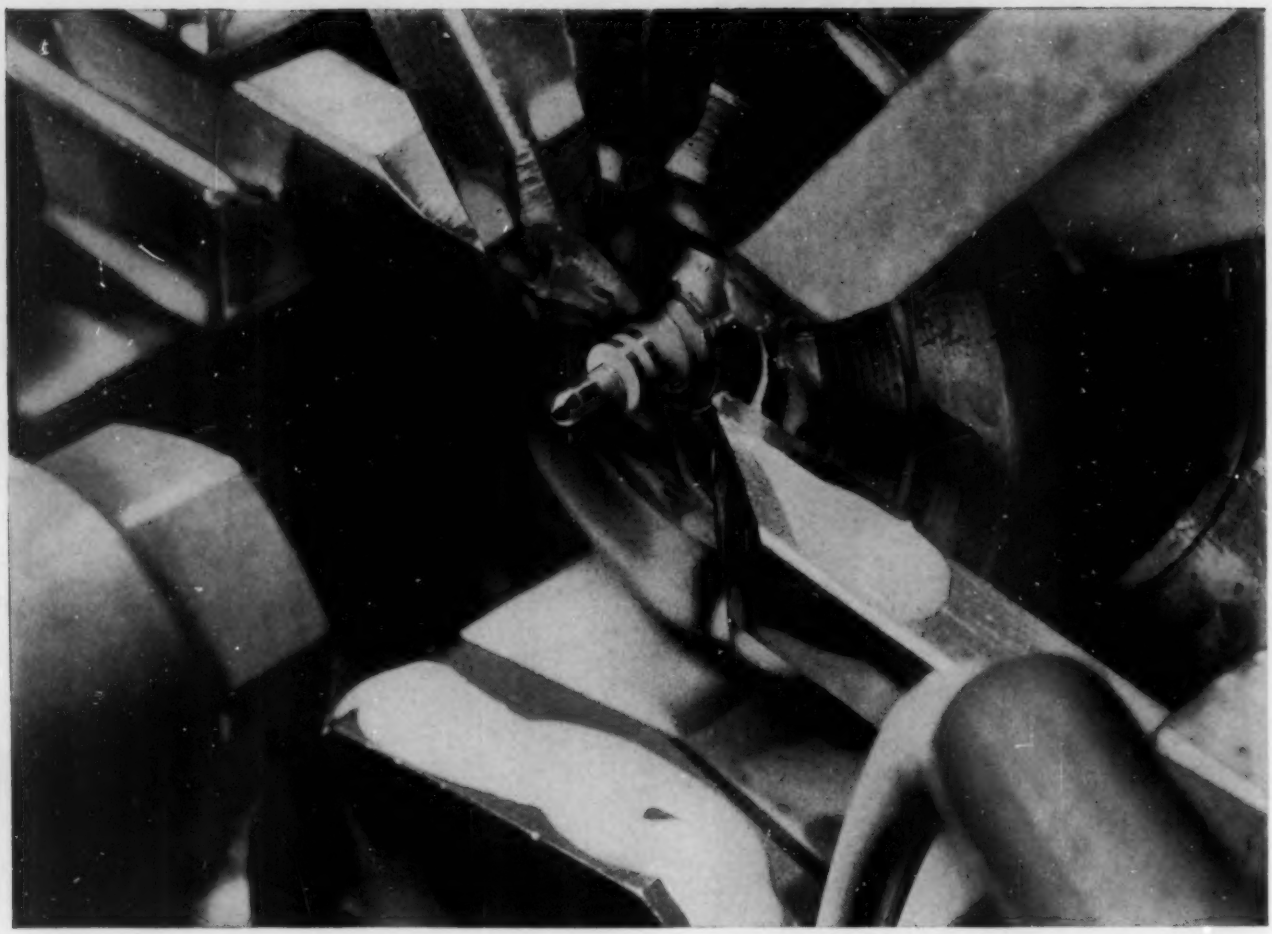


TURNING "Berylco" Beryllium Copper rod in Swiss screw machines at Molded Insulation Company, Philadelphia, Pa.

Machining "Berylco" Beryllium Copper is a run-of-the-mill operation at this plant

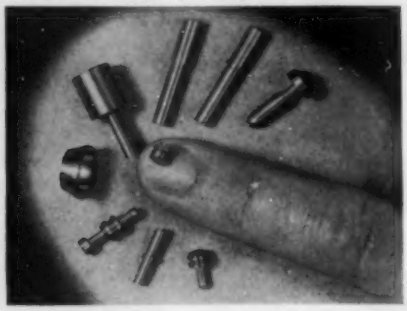
Beryllium copper has long been regarded—by people who have never tried it—as a difficult alloy to machine. Usually the reverse is true, as Molded Insulation Company can testify.

This manufacturer regularly produces a wide variety of small precision parts from "Berylco" Beryllium Copper. The use of most of these parts is classified; many are designed to improve electrical connectors and communications equipment. Drilling, turning and cutting are done on Swiss screw machines. The parts are also slotted, tapped and milled. Standard tools and drills are used, and no special tool set-up is necessary. Surface speeds run 200 fpm—or even higher on small diameter stock—and the best coolant has been found to be a good water-soluble oil. Clogging is no problem: in fact, the company finds more difficulty with brass and bronze in this respect.

From the beginning, The Beryllium Corporation worked closely with this producer, conducting special hardness and tensile tests and furnishing material that would run well on the Swiss machines. It will be glad to work with you, too. Write, phone—or, if you prefer, blueprint your problem—and let us suggest a solution.

MICROSCOPIC inspection.

TYPICAL PARTS produced from "Berylco" rod on Swiss screw machines.



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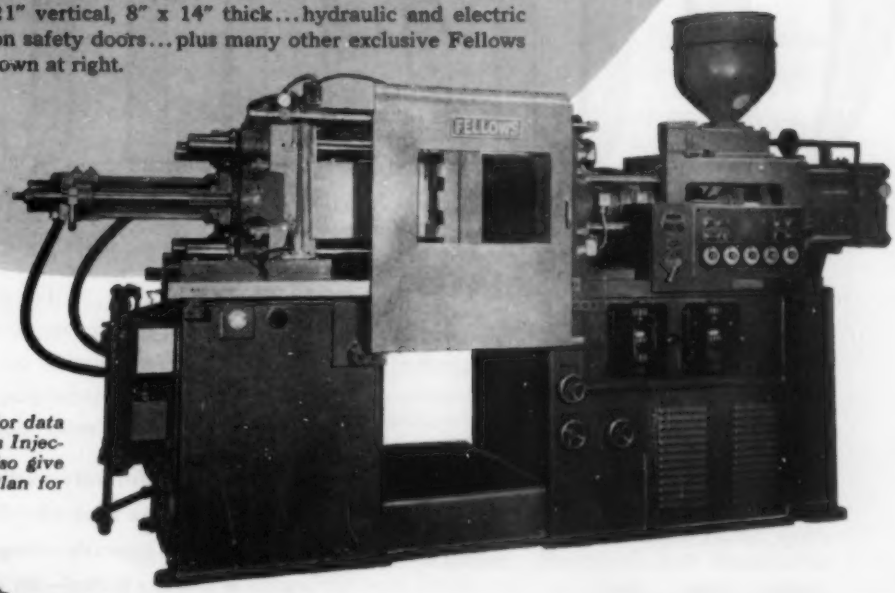
✓ **CAPACITY**—The "6-200" is the fastest fully automatic FULL 6 OUNCE machine on the market! "Pre-Pack and Pre-Positioned" device (optional) brings plunger halfway forward during press dwell . . . providing up to 8 OUNCE "SHOTS."

✓ **SPEED**—Thanks to such features as variable stroke adjustment, rapid advance injection, and new, improved Speed-Flo heating cylinder . . . the "6-200" delivers "dry-run" speeds from 490 to 650 cycles per hour.

✓ **FULLY AUTOMATIC**—Only the "6-200" gives you all the automatic features which allow one man to operate three or more machines! Grouped built-in temperature, injection pressure and speed controls! Counter, air-blast connections, alarm timer and safety device for mold . . . as extra equipment!

✓ **EASY SET-UP**—Entire press hydraulically retracts from nozzle for purging . . . plenty of open space on all sides of die platen . . . mold opens 6 to 9 inches . . . single control clamping adjustment.

✓ **BONUS FEATURES**—The "6-200" takes 12" x 24" molds horizontal, 15" x 21" vertical, 8" x 14" thick . . . hydraulic and electric interlocks on safety doors . . . plus many other exclusive Fellows features, shown at right.



ASK *your Fellows Representative for data about the complete line of Fellows Injection Molding Machines. He can also give you information on the Fellows Plan for deferred payment.*

Fellows

injection molding equipment

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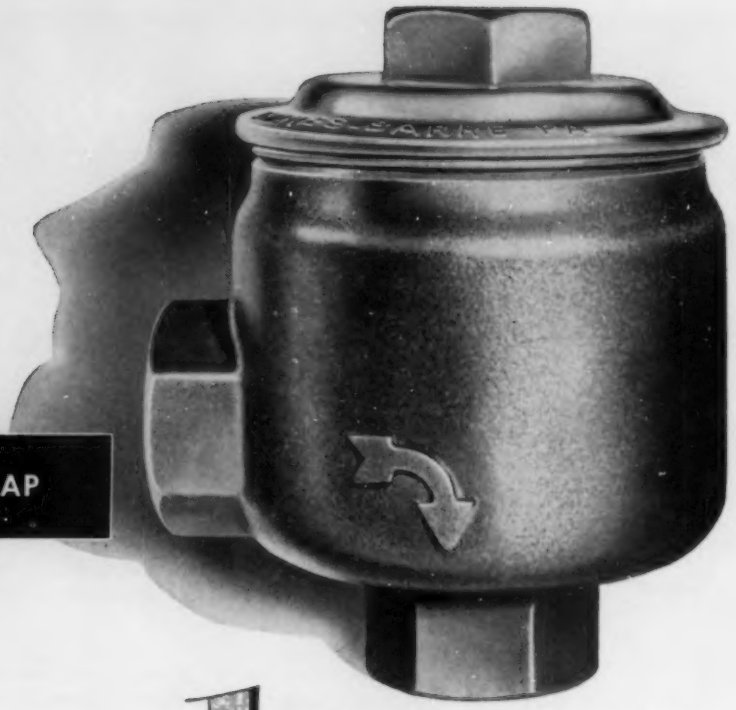
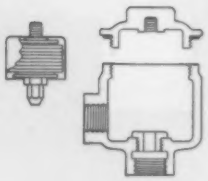


STEAM TRAP

Quality

Just 3 quality parts—thermostatic bellows, body, cap. Simple, positive action. Won't leak!



Nicholson quality . . . that gives you the extra strength, extra capacity, extra *stamina* required for severest steam-using equipment service. Nicholson quality pays off, when it comes to discharging condensate and air from steam lines . . . most efficiently, dependably, economically.

- **Powerful valve action—big husky bellows.**
- **Positive shut-off—finely ground valve and seat.**
- **High capacity—large diameter orifice.**
- **Rigidly tested—on actual steam lines.**

When less than best won't do, specify Nicholson. Send for *Catalog 953*.

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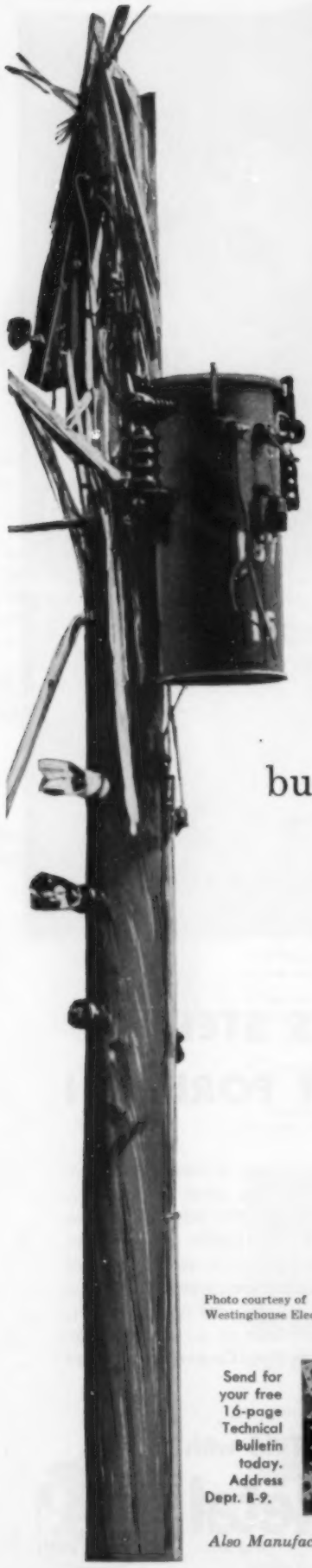
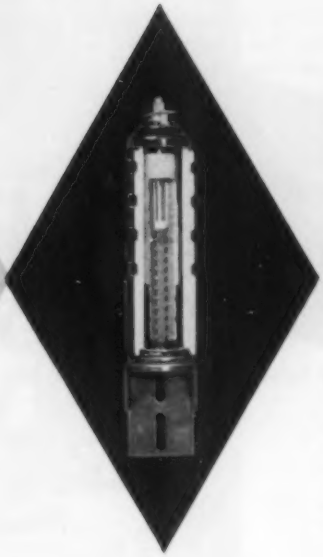


lightning made a direct hit



Here's where the action took place! This shows the transformer's "safety valve" of National Vulcanized Fibre. Sleeve and threaded spiral insert —both supplied in the form of precision-fabricated parts—are constructed of this tough, arc-resistant cellulose material. Spiral construction of arc chute insert distorts, elongates and tames electric arc so that no damage is done. At the same time, heat causes the fibre to release an arc-quenching gas. Result: perfect safety for valuable equipment protected by National Vulcanized Fibre.

but couldn't knock out the transformer

how a National Vulcanized Fibre part costing only a few dollars saved a transformer worth thousands, and was ready to go to work again

Lightning blasted this line pole like an exploding bomb—but left the Westinghouse distribution transformer undamaged. There wasn't even a minute's interruption in the flow of current.

Reason: National Vulcanized Fibre. A diffuser assembly of this tough arc-resistant material in the transformer's lightning arrestor bypassed the tremendous surge of voltage—tamed and quenched the arc —dissipated the heat and discharged the gases of the arc harmlessly.

It cost the power company only a few dollars to safeguard equipment worth thousands. And there's *your* clue to safety *and* savings in power switching equipment and thousands of other electric applications. Fine electrical properties and mechanical toughness—excellent machinability—unusual formability—light weight—great resistance to heat, shock and abrasion—National Vulcanized Fibre has them all. And you get them at low cost!

Somewhere in your products or your processing, there's a use for versatile, economical National Vulcanized Fibre. Let's explore the possibilities together. Technical and descriptive literature and application assistance for the asking.

Photo courtesy of Westinghouse Electric Corp.

Send for your free 16-page Technical Bulletin today. Address Dept. B-9.

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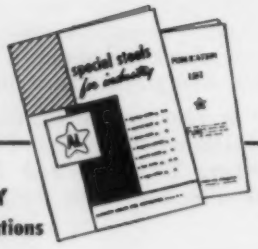
Beautiful? YES—THEY'RE STAINLESS STEEL
Expensive? NO—THEY'LL LAST FOREVER!



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Allegheny Metal *lasts!* As far as anyone knows, it won't wear out, and it can't wear off because it's solid . . . the same bright, hard, immensely strong metal all the way through. No other metal can match stainless steel in this combination of desirable qualities. So, whether you're thinking about pots and pans, or anything from safety pins up to railroad trains and skyscrapers—remember that Allegheny Metal costs less in the long run because it *lasts* longer, and because it stays beautiful for life with little or no maintenance. ● Let us help *you* use it. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

Make it BETTER-and LONGER LASTING-with

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WAD 5377C

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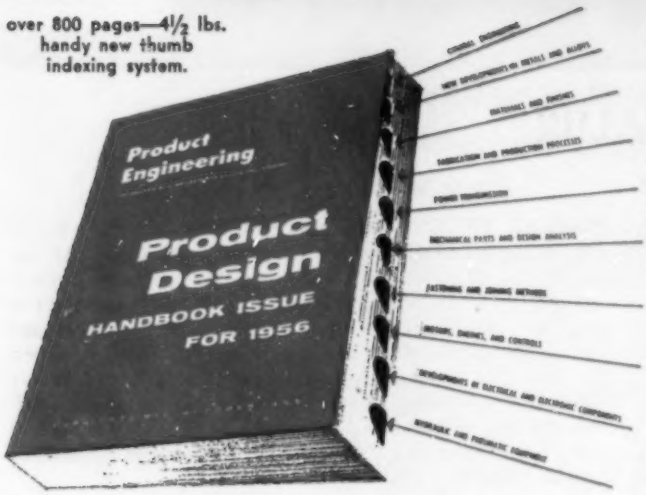

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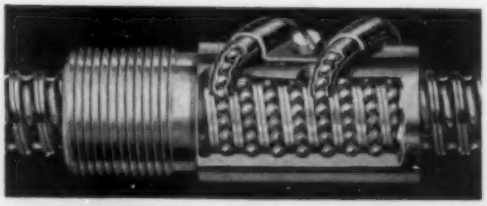

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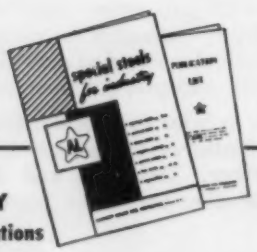

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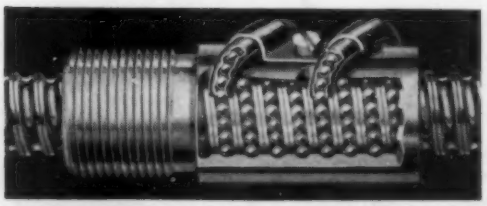

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1.500	.34375	.47368
2.250	.375	.500
3.000	.500	.660

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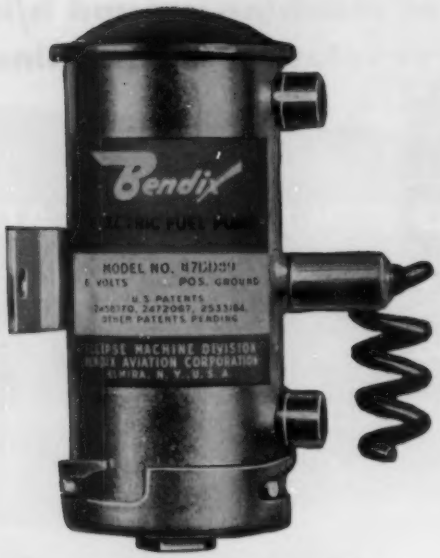

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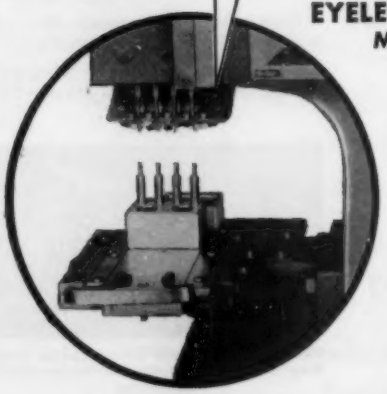

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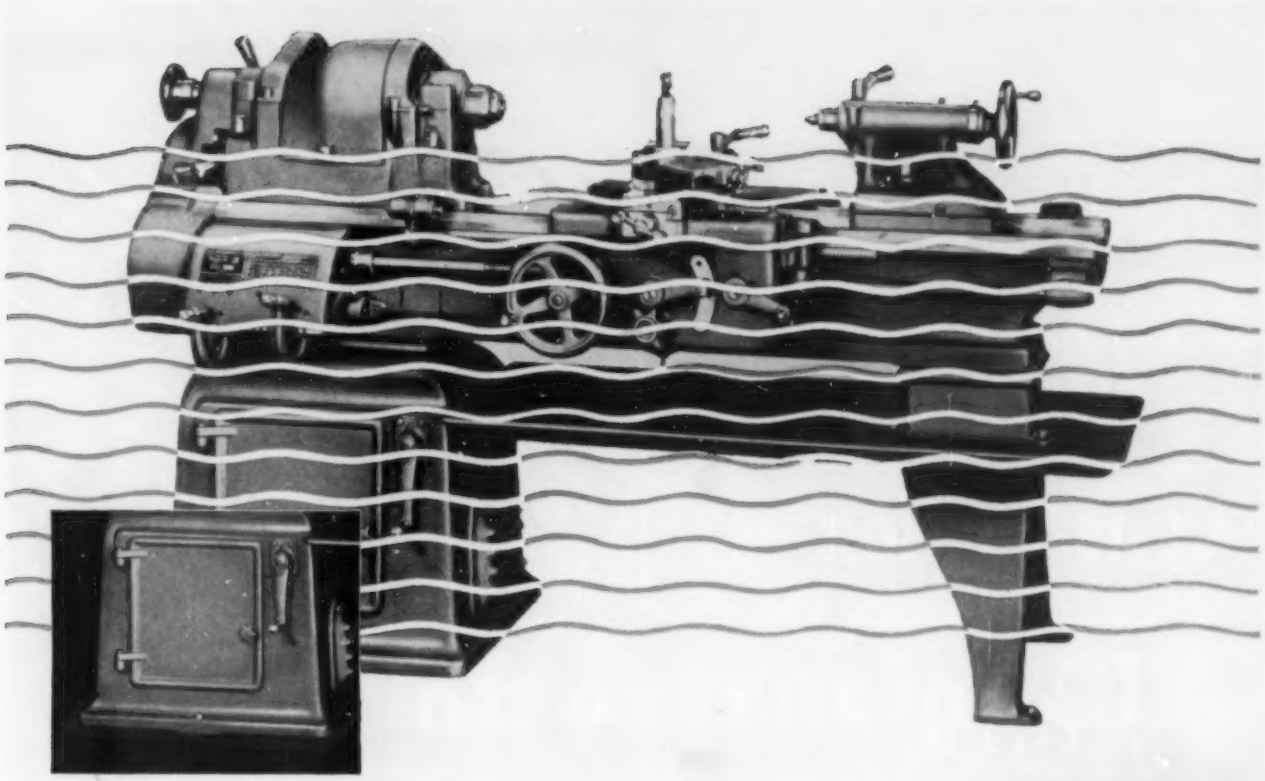

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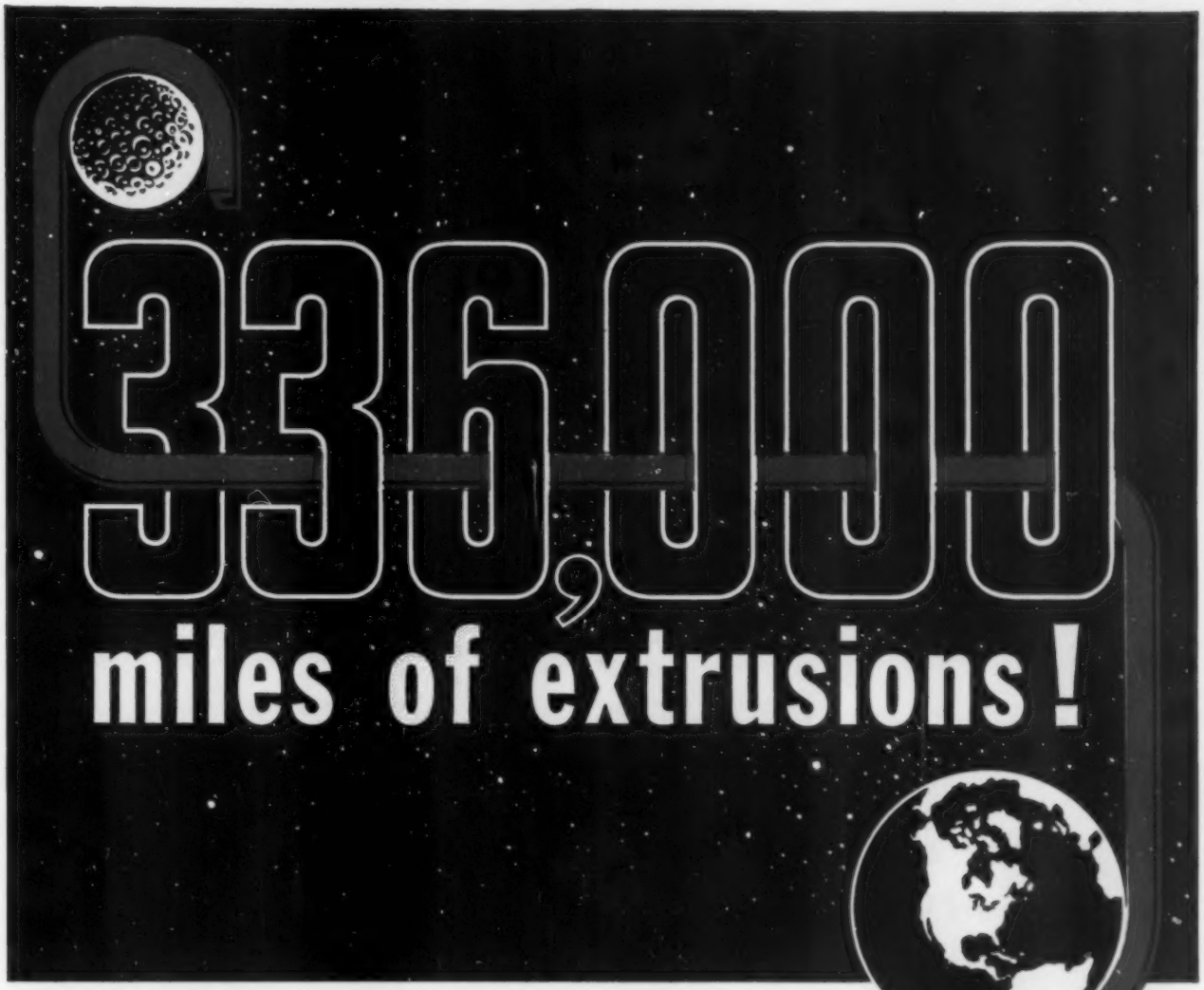

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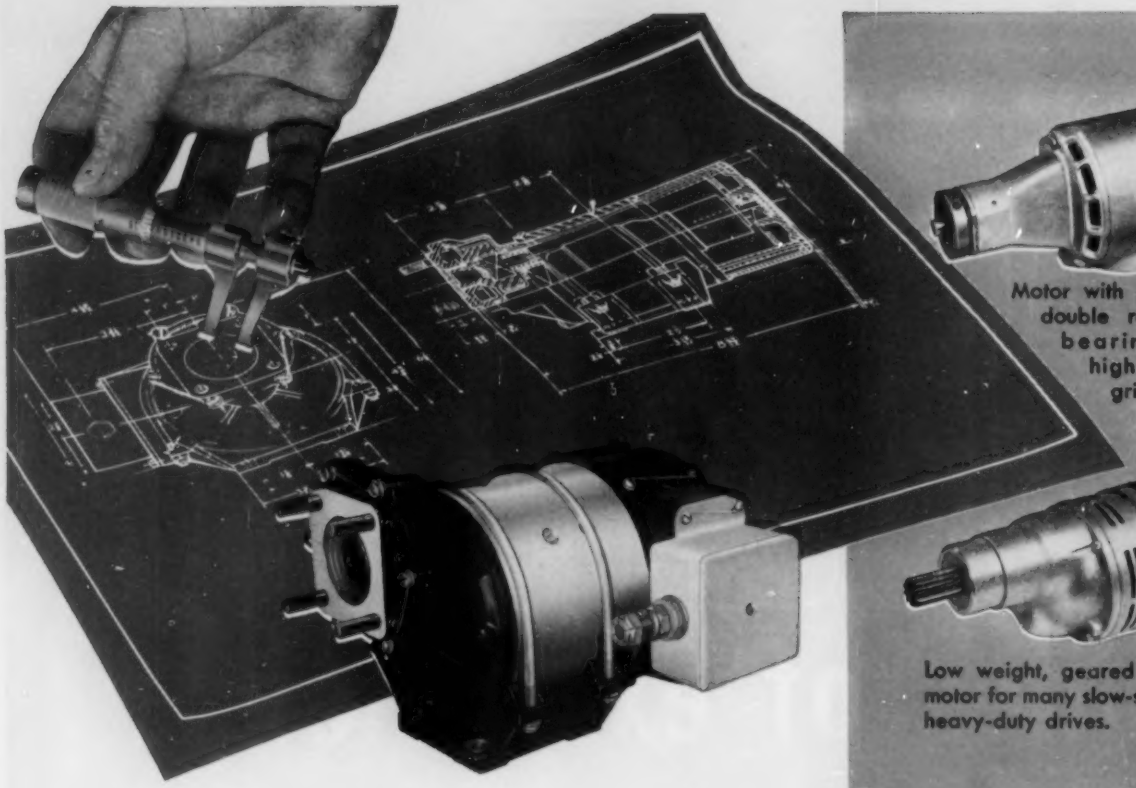
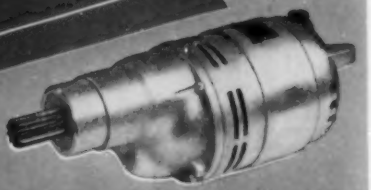


Motor with shaft on double row ball bearings for high speed grinder.



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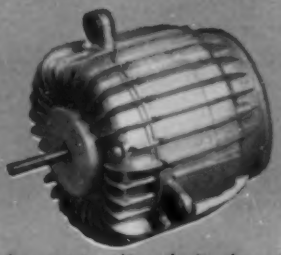

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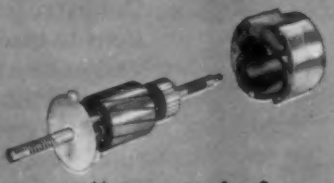

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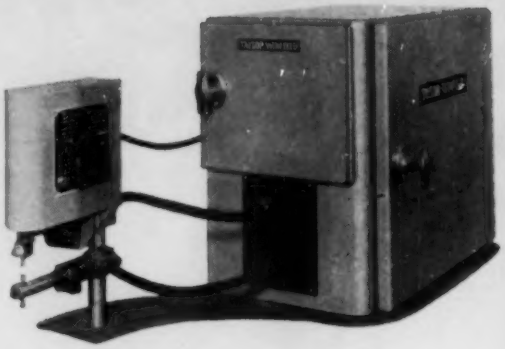

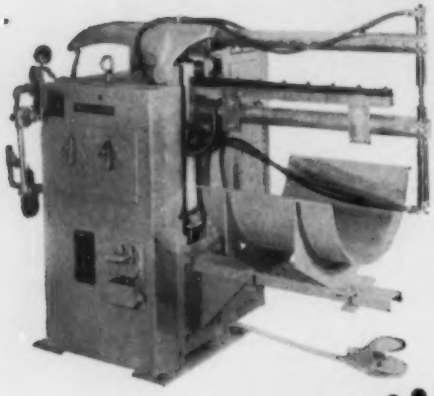

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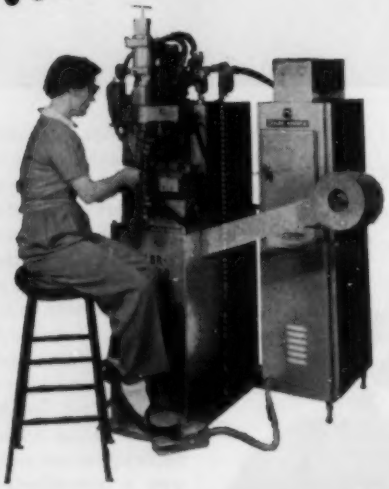

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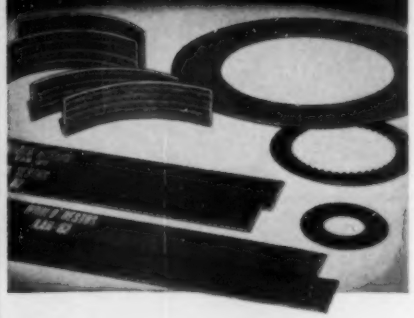

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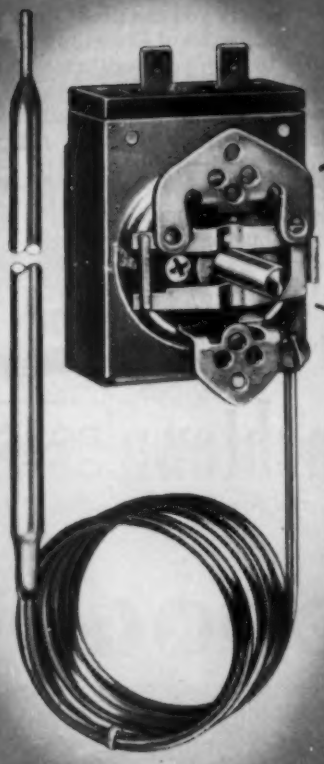

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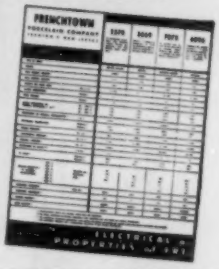

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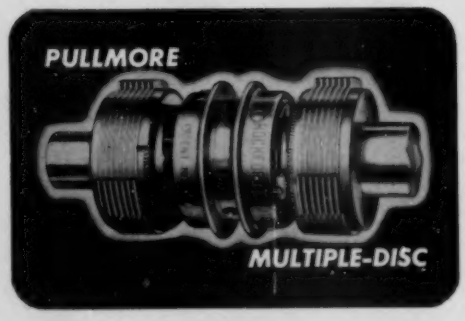


HIGH TORQUE LOW ENGAGING PRESSURE

COMPACT DESIGN
HIGH TORQUE
HIGH RATIO LEVER
POSITIVE NEUTRAL
PRECISION BUILT
LONG WEAR LIFE
EASY ADJUSTMENT

• PULLMORE discs provide high capacity and efficient lever design enables light engaging pressure. Discs are accurately made from special clutch-disc materials and are tested for flatness. Made in single and double types, for operation in oil or dry, PULLMORE clutches have capacities from 1 to 90 H.P. at 500 R.P.M. They handle loads of much greater than rated capacity, when operated at higher speeds.

Send for This Handy Bulletin

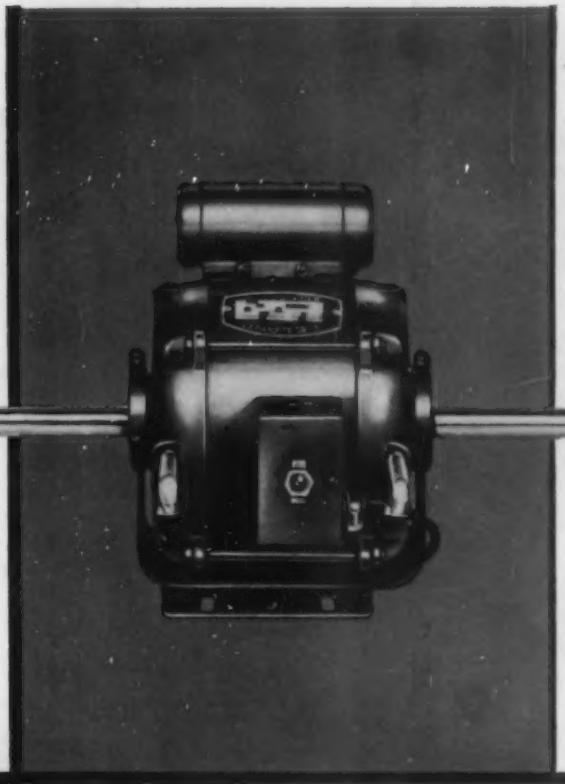
Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

BW

ROCKFORD CLUTCH DIVISION BORG-WARNER
▲ 209 Catherine Street, Rockford, Illinois, U.S.A. ▲

CLUTCHES

Specify more than "satisfaction"



specify

LELAND

No product is any better than its components . . . no motor any better than what went into it — in design, materials, in craftsmanship.

And Leland's policy has always been to *go beyond* minimum requirements . . . to give you the *extra* value that *assures* dependability, that *surpasses* mere customer "satisfaction"

It has meant painstaking, creative design. Often the use of finer materials. Always more rigorous quality control. But that policy has proved successful because users *know and appreciate* the extra value a Leland motor offers.

Look for more than "satisfaction" from the motors *you* specify, buy or use. It costs you no more . . . it does mean a finer, more reliable product.

Another AMF Product

LELAND MOTORS

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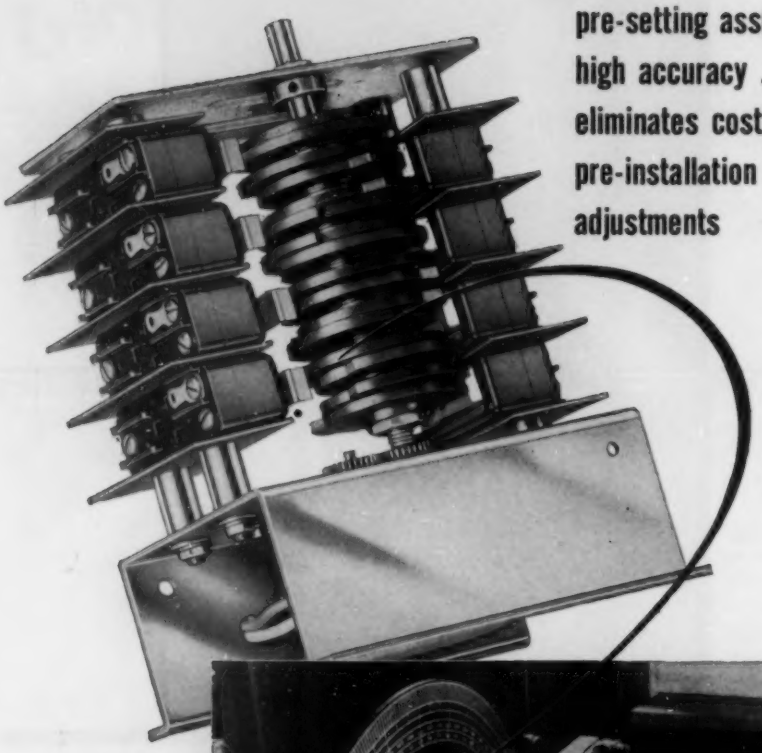
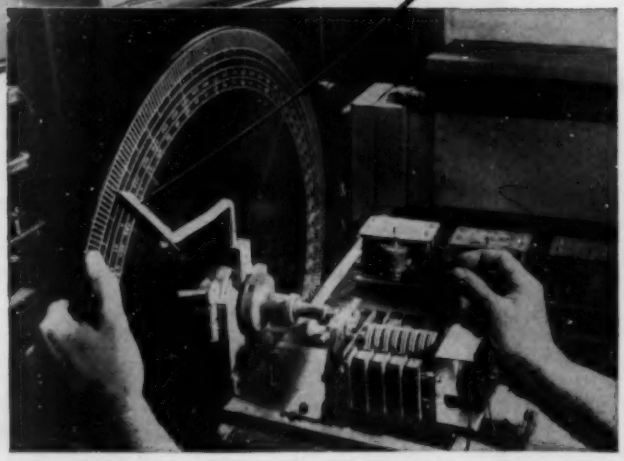


Factory pre-setting assures high accuracy . . . eliminates costly pre-installation adjustments



Cramer CYCLING TIMERS

The accuracy of a cycling timer depends on the exactness of the cam settings. If any one of the driving cams is incorrectly set, even to the minutest degree, the over-all program pattern or sequence of operations is changed.

Cramer cycling timers are normally supplied with all cams pre-set to customer specifications on special calibration equipment like that shown above. This pantographic principle, in effect, produces a sixteen-time enlargement of the cam, permitting extremely close setting accuracies.

While these timers can be adjusted in the field, factory setting assures highest accuracy and eliminates costly pre-installation adjustments.

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For full information about Cramer Cycling Timers, write for new Bulletin PB-510.

Cramer TIMING DEVICES

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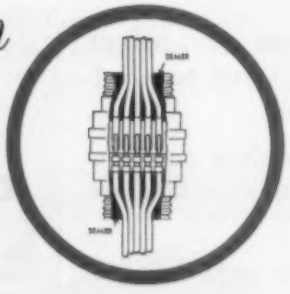
Thiokol.
LIQUID POLYMER
Solves Problem of Sealing Electrical Connectors against Moisture and Vibration



Problems in sealing electrical connectors against moisture, solvents and contamination under conditions of severe vibration and temperature extremes can be solved with potting compounds based on "Thiokol" Liquid Polymer.

"Thiokol" Liquid Polymer potting compound comes in the form of a paste and is pressure flowed into the voids around wiring. It sets at room temperature to a resilient rubber with good dielectric properties and adheres tenaciously to metals, glass and plastics.

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Our technical staff will gladly discuss the suitability of "Thiokol" Liquid Polymer for any electrical potting or sealing job you have in mind.

Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymer only as a raw material. We will gladly indicate sources of suitable compounds to end-users.

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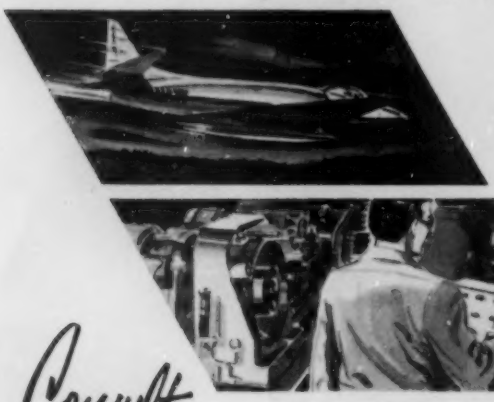

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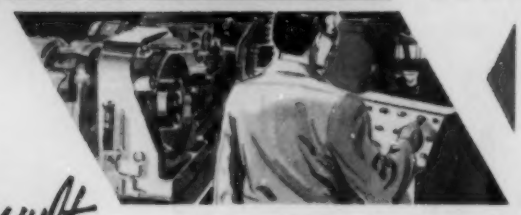

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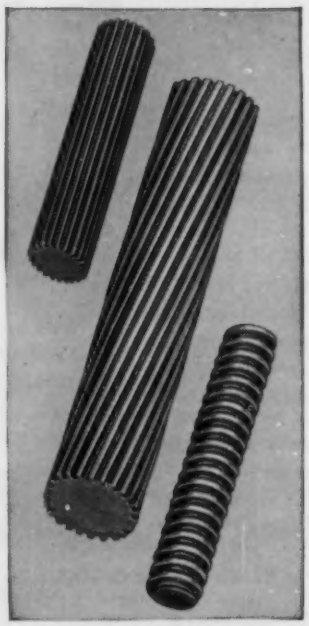

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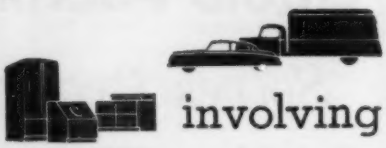

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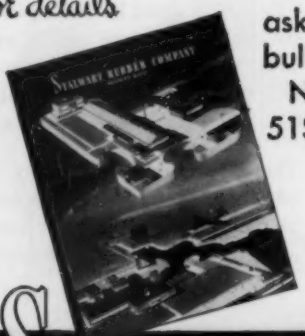

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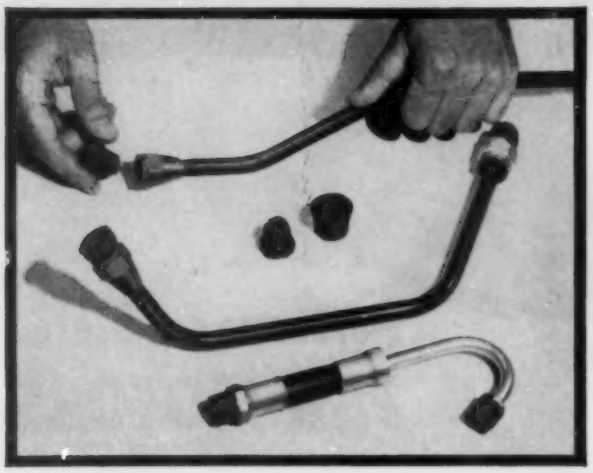

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Stocked in over 200 sizes (up to 8" in dia.), CaPlugs are readily obtainable to protect your products profitably, too!

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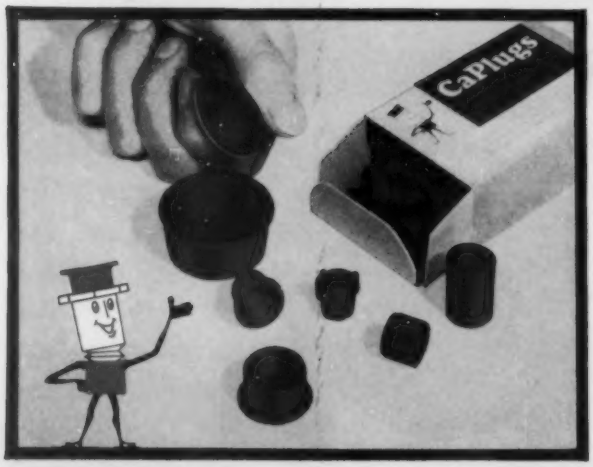

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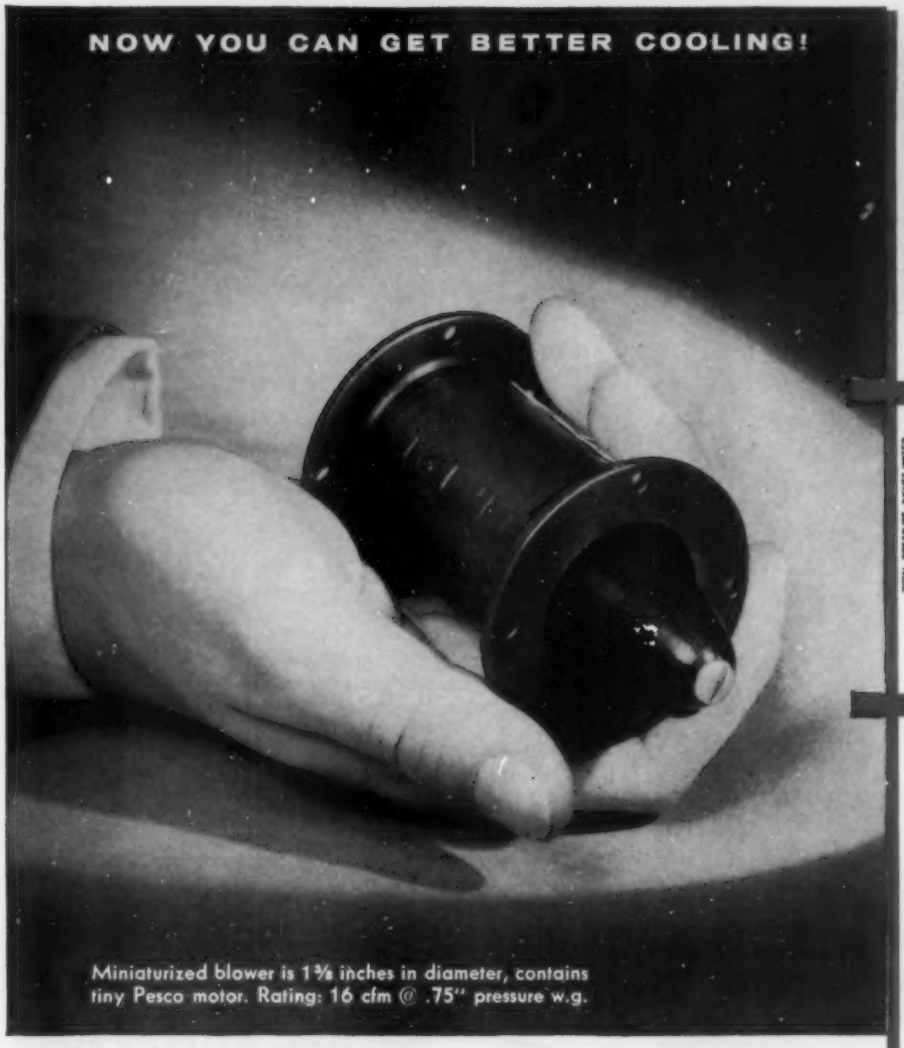
NOW YOU CAN GET BETTER COOLING!
Miniaturized blower is 1⅝ inches in diameter, contains tiny Pesco motor. Rating: 16 cfm @ .75" pressure w.g.

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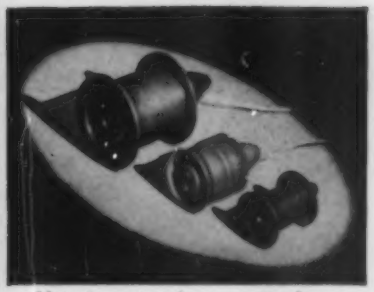
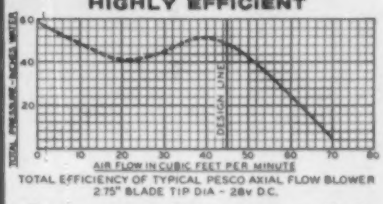


Units for a-c or d-c operation have capacities from 16 to 750 cfm.

HIGHLY EFFICIENT



TOTAL EFFICIENCY OF TYPICAL PESCO AXIAL FLOW BLOWER
2.75" BLADE TIP DIA - 28v D.C.

Design assures efficiencies unexcelled in comparable "package" sizes.

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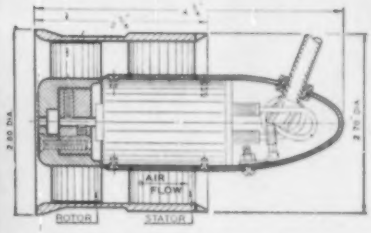

High air displacement and pressure achieved with minimum size and weight.

new Pesco axial flow blowers

More efficient air delivery or exhaust is possible with the new Axial Flow Blowers now manufactured by PESCO. Engineered by a leading British firm, these advanced design blowers have been proved under tough service conditions. They provide better cooling, heating or ventilating for a wide variety of aircraft and industrial applications.

PESCO® Axial Flow Blowers are self-contained package units which save space and permit more flexible product design. They incorporate a rotor direct coupled to a PESCO Electric Motor for efficient air flow.

An outstanding characteristic of this new PESCO product is the high capacities obtained with minimum power. Careful aerodynamic design assures optimum efficiency with axial air flow. PESCO Blowers withstand severe conditions of shock, temperature, pressure, altitude, humidity and duty cycle. Rated for continuous operation at high ambient temperatures, they perform in any position. Dynamic balancing assures quiet, vibration-free operation. Flange or clip mounting is optional.

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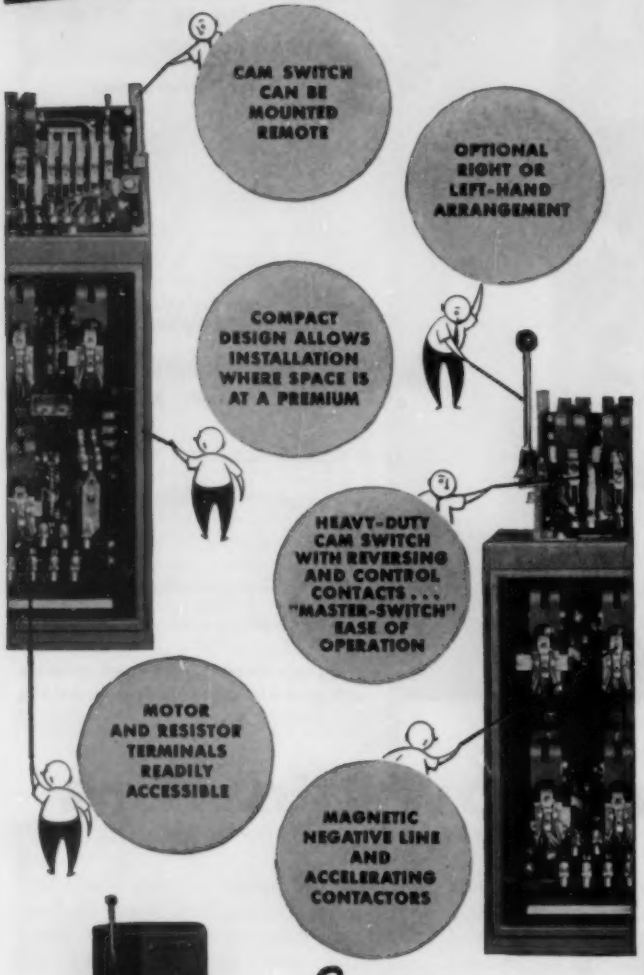
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HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
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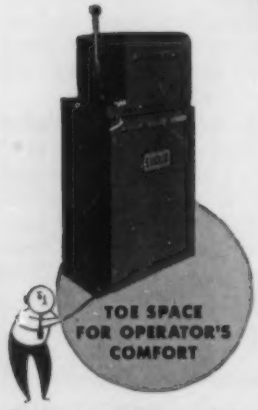

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For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.
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Simplify assembly and setting of Adjusting Screws

The new Tension Type PALNUT Lock Nut is tightened *once* when assembled and never touched again no matter how often the screw is adjusted. Only a screwdriver is needed.

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How it works:

Resilient spring design assures smooth but powerful hold on screw threads for accurate settings, despite vibration.

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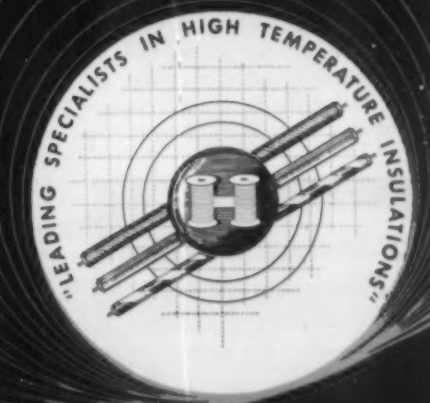

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ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by C. Hotchkiss, Jr.
Application Engineer,
Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

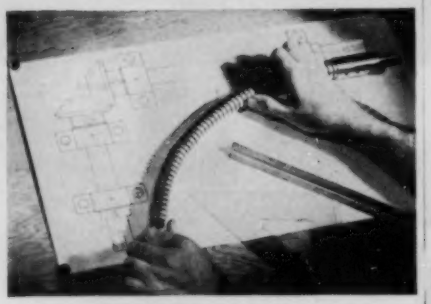
2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼ inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.



Relative Motion—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾ inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Company.

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛ inch to 1¼ inches; for remote control applications in diameter sizes from ⅛ inch to 1⅝ inches. The 1¼ inch power drive shaft will transmit up to 10 HP while the 1⅝ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering Bulletin 525.

STOW MANUFACTURING COMPANY
426 STATE STREET, BINGHAMTON, NEW YORK

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One oil seal for every purpose!
Universal Oil-Seals are assembled units ready for installation at vital friction points. They are available in special designs up to 48" diameter shafts with optional leather, synthetic rubber or composition packings.
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SITTING PRETTY...

...on LORD foot mountings

2-in-1 FLEXIBLE FOOT: LORD bonded-rubber unit for new Burroughs' business machine provides separate mounting of chassis and base.

The new Burroughs' Ten Key Adding Machine has foot mountings designed by LORD. Despite their apparent simplicity, the mountings had to (1) assure noiseless, cushioned performance, (2) match the machine's color, and (3) overcome migratory and contact staining of desk tops.

The LORD bonded-rubber mounting shown was designed to meet these tough requirements. It effectively isolates vibration by separate mounting of chassis and base. The specially compounded rubber does not stain or mark desk-top surfaces. Color-matching was achieved without impairing the good vibration control characteristics. As a result, Burroughs' new machine is "sitting pretty"—with its advantages of quiet operation, attractive appearance and non-marking feet assured by LORD mountings.

LORD can make bonded-rubber foot mountings in a variety of sizes and shapes to enhance the beauty and operational appeal of your business machines. We will be glad to discuss specific applications with you. Contact LORD today.

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designers and producers of bonded rubber products since 1924

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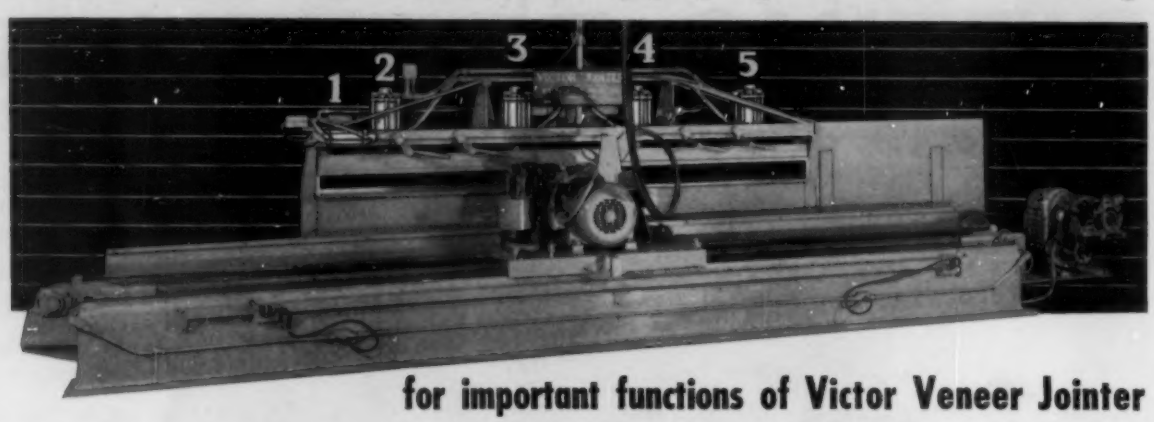
5 NOPAK Cylinders supply pressure and pull



for important functions of Victor Veneer Jointer

The Victor Straight-Line Veneer Jointer, built by the E. V. Prentice Co., Portland, Ore., employs a NOPAK Model E 2½" x 6" Cylinder to operate the stops which align the stock, and 4 NOPAK Model D, 6" x 5" Cylinders to exert adequate, equalized clamping pressure on the full length of the stock to be joined. All cylinders are controlled from a single station to provide for fast precision alignment and clamping in a rapid, repetitive work cycle.

This is another example of the important role played by NOPAK Cylinders and Valves in actuating and controlling precision machine movements. Others are shown in the NOPAK Application Manual. Ask your NOPAK Representative to show you this helpful book.

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★ High Resistance to Wear
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Arens can supply you with accurate, efficient push-pull controls, custom built to your requirements. These range from simple spring wire casings to rigid controls, and include controls with various protective coverings, locking devices, fittings, etc., both standard and special designs. Our new 40-page catalog gives you complete information.

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Gear reduction unit and easily detachable standard end-mounted motor — combined for big maintenance savings. Permits (1) replacement of motor without disturbing gear unit, (2) replacement of original motor at any time with motor of special characteristics (totally-enclosed, etc.)

New **FLANGED REDUCTORS**
The Ratio motor gear reduction unit, supplied *without* motor. You buy and attach the motor of your own choice.

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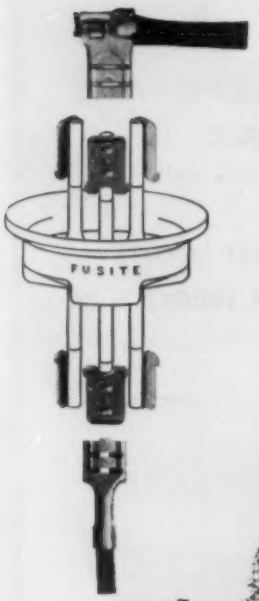
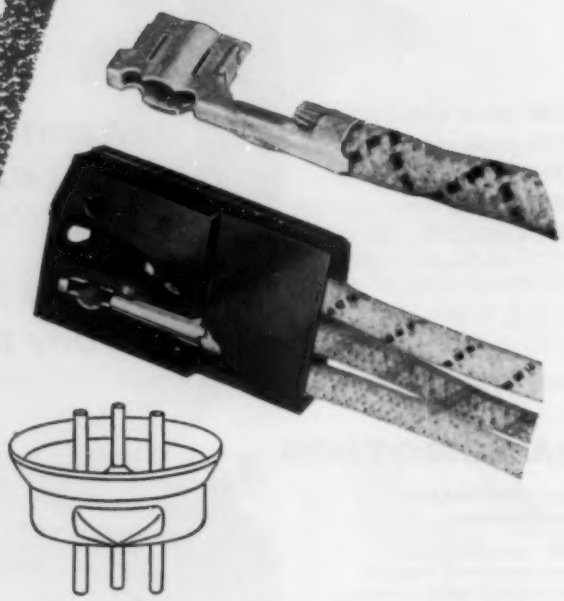


2. For higher horsepower compressors, such as used in air conditioning industry. AMP Faston Tabs welded to pins of hermetic-seal terminals mate with AMP Faston Receptacles.



1. AMP's multiple connector assembly for low horsepower hermetically sealed compressors, such as used in refrigerators and freezers. AMP's snap-in feature permits quick assembly of connector. Molded block assembly snaps on all three hermetic terminal pins in one motion. Result—fully insulated, reliable, solderless connection.

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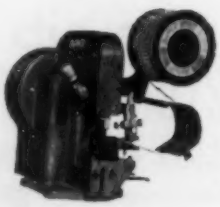
The AMP Faston approach provides the ultimate in electrical performance and speedy assembly.



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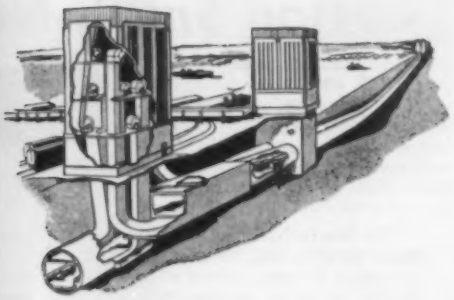
Morse equipment helps ventilate Lincoln Tunnel for 18 years — without replacements!



Lincoln Tunnel: Operated by The Port of New York Authority, it is a major artery connecting mid-Manhattan with New Jersey.

Here, 26 blowers and 30 exhaust fans circulate millions of cubic feet of air per minute through the tunnel. Because these ventilation units provide a complete change of air in the tunnel every 1½ minutes, they require dependable power transmission equipment. It is significant that Morse power transmission equipment is used in many of these units.

Shown at left is a typical blower unit, which employs a 6 in. Morse Silent Chain operating at 7½ hp at 445 rpm or 60 hp and 884 rpm. This unit, as well as the others in the ventilation system, has been operating for 18 years with little maintenance, and no breakdowns.

Check These Advantages of Morse Equipment:

- Long service life
- Low operating cost
- Easy to assemble, disassemble
- Require minimum maintenance
- Wide range of types and sizes
- Precision construction

Morse Power Transmission equipment gives reliable, economical performance in unusual applications.

Look into the complete line of Morse Power Transmission products which you can employ in your own design applications. Morse has skilled engineers available to help you solve practically any problem involving transmission equipment: Roller Chain, Silent Chain, Sprockets, Clutches, and Couplings.

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MORTON *Smith-Nobak Device*

The Smith Nobak Device permits both shafts to rotate simultaneously. When power stops, the device prevents further rotation of the mechanism either from the initial inertia force or from an external force applied from anywhere except the original source. The driven shaft is locked in position to prevent its rotation in either direction. Application of power unlocks the device instantly.

The device is finding numerous uses in automation, aircraft control mechanisms, hoists, transfer tables, conveyors, punch presses, printing presses, and wherever a positive control of angular position is required. It is especially adaptable for feeds into presses and boom hoists of derricks. Load ratings from 50#in. to 2600#in. are available.

4-page bulletin and technical data available on request. Specific recommendation will be sent you on receipt of your requirement.

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A shaft position to digital conversion component for data handling systems and digital computers. Multi-brush pick-offs eliminate ambiguity. Adapted to be used in digital to analog conversion systems and closed loop systems. Standard unit handles 13 digits; 7, 17, and 19 digit models also available. Multi-channel converters designed to be time-shared with one scan network. Custom models may be ordered to your specifications.

SPECIFICATIONS:

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Length: 2-3/4 to 5", according to model
Torque: Under 0.2 oz. in.
Meets applicable military specifications

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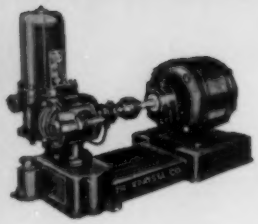

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Air-cooled design — or water-cooled models for heavier duty.

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is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

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KRAISSL KRAISSL CO

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Cold flow resistance of TEFLON* and reinforced TEFLON (DUROID 5600) was tested at 100° F., under a torque of 35 pounds and a flange pressure of 1,000 p.s.i. After 2 hours the flanges were cooled and the bolts retightened. The flanges were then exposed to the heat for another 2 hours. Results are as pictured. The gasket of TEFLON (left) extruded extensively on all edges and lost all bolt torque. DUROID 5600 did not extrude and retained 15 pounds bolt torque, demonstrating significantly improved resistance to cold flow.

Greater Resistance to Heat Distortion

TEFLON (left) distorted badly when subjected to 720° F. and then cooled. Reinforced TEFLON (DUROID 5600) exposed simultaneously to the same temperature retained flatness, demonstrating greater dimensional stability at high temperatures.

SOME IMPORTANT TEST VALUES

Tensile Strength, MD, psi	2500
Tensile Strength, CMD, psi	1500
Compressibility, 5000 psi, %	8
Thermal Expansion Coefficient per °F., 73-140°F.	2.7×10^{-5}
Heat Distortion Temperature, °F.	
66 psi	500+
264 psi	500+
Deformation under Load, %	
1200 psi	2*
2000 psi	3*
Coefficient of friction against polished steel,	
static	.21
kinetic	.14
Specific Gravity	1.90

*Made up of actual flow and also of compression under load. Data to indicate breakdown between these two portions is being obtained.

ROGERS REINFORCES "TEFLON" TO REDUCE ITS COLD FLOW

Rogers DUROID 5600 is a combination of TEFLON and inert fibers, blended into an homogeneous sheet material. This new material is not a replacement or a substitute for TEFLON, but rather an extension of it. TEFLON has better electrical characteristics and dry lubricating qualities. DUROID 5600, however, has much of TEFLON'S resistance to chemicals, and is greatly superior to TEFLON in resistance to cold flow and heat distortion.

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*Registered trademark of DuPont Company for its tetrafluoroethylene resin.

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Model 1032 *Strokontrol Ram* has 3½" bore; 8,13 or 16" stroke. Double action with hydraulic depth stop.
Model 1002 *Horsepower Ram* has 3" bore; 8, 10, or 12" stroke. Double action converts to single action.

HORSEPOWER VALVE
Model 960 with Holdkontrol provides manual or automatic return to neutral. Has built-in 1000 psi pressure relief valve. No additional parts to convert from double to single acting.

HORSEPOWER PUMP
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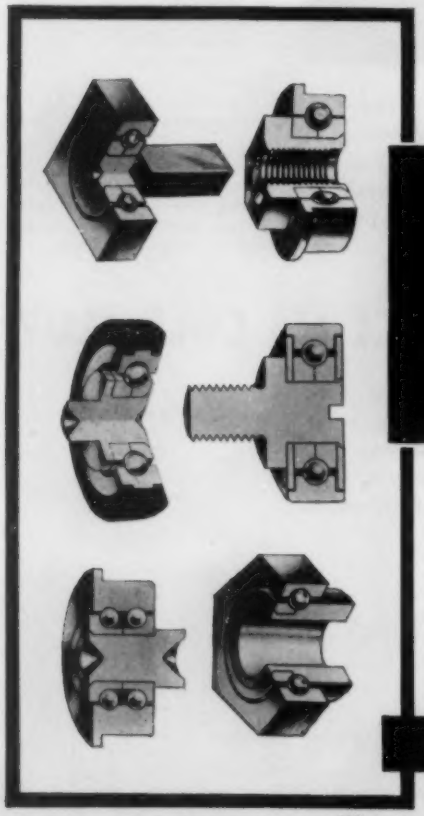

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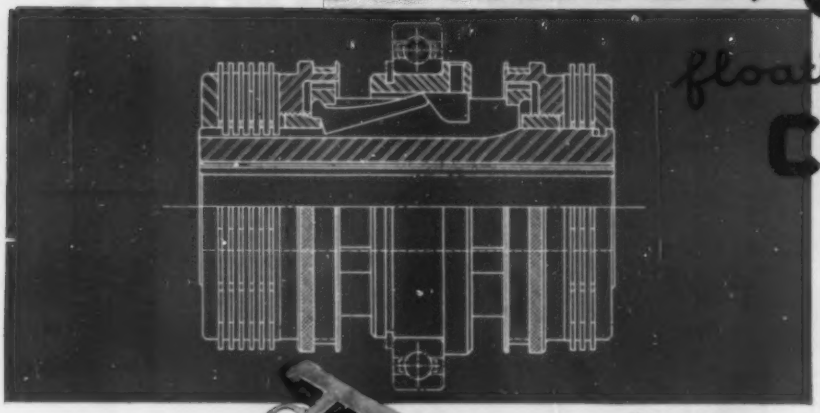

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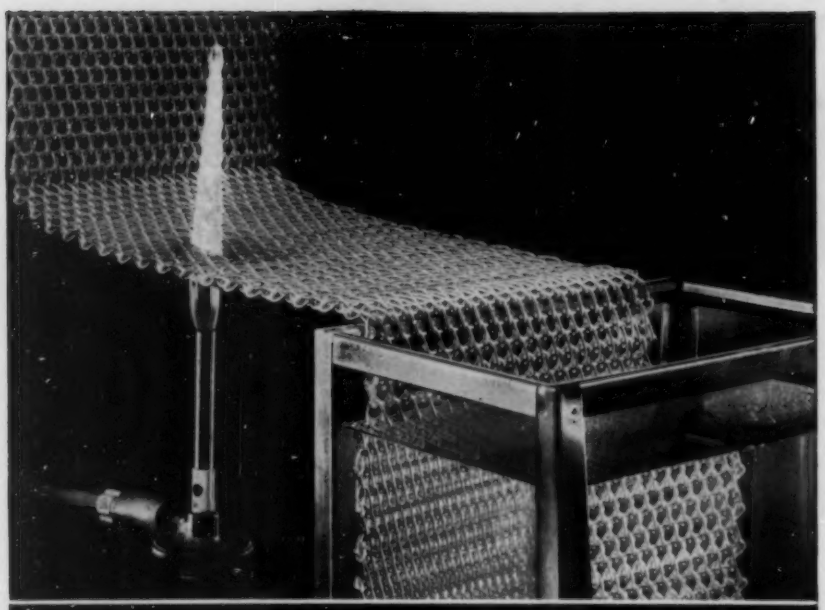

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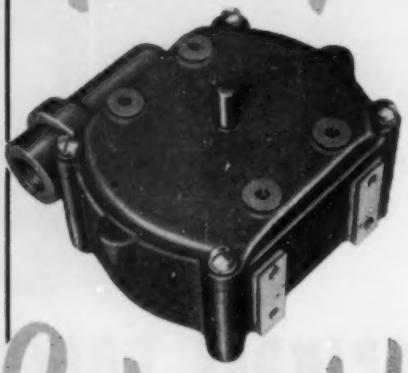

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DIVISION OF LEE SPRING COMPANY, INC.

How the design, development and production team at Burgess-Norton made possible

Cost Savings of 17% On this Clutch Hub

Here is another example of how redesign for modern production methods produced a better part at lower costs. This clutch hub was formerly made from a machined forging. By combining a screw machined part and a stamping through hydrogen-copper brazing, as shown below, production costs were reduced 17% . . . greater control on flange tolerances obtained, and eight stop lugs could be used instead of only four.

The original forged hub design required greater machining time, and often had excessive scrap because of flange thickness variations.

Basic components of the new design are a stamped and formed flange and a screw machined center hub.

The two parts are then assembled with copper rings and brazed under controlled atmosphere conditions to eliminate oxidation.

After the hydrogen-copper brazing operation, the hub splines are cut on horizontal broaching machines.

Final operations are in the stamping department, where spring slots are pierced and stop lugs formed.

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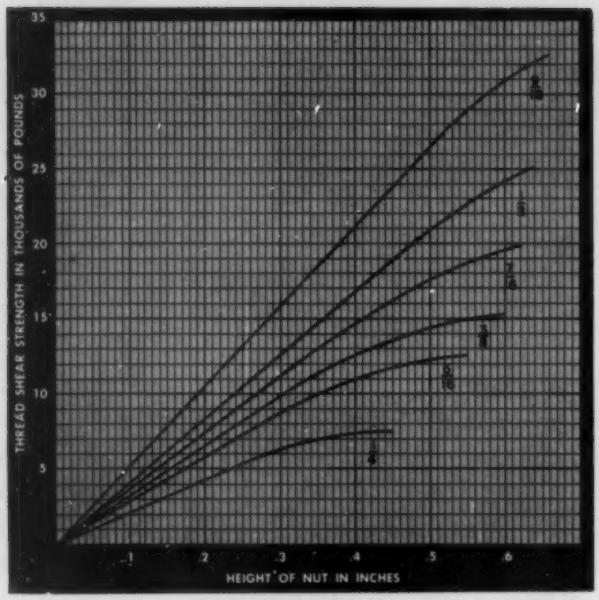

Figure 2

24 page engineering data... Section

Figure 2, Height vs. Shear Strength, on page 5 in our new Engineering Data Section of our catalog, is just one of the several factors that are discussed on pages 3, 4, 5 and 6 for applications of finished hexagon nuts (fine and coarse threads) where highly stressed bolts of special material are required. . . . Fourteen topics, concerning the technique in the manufacture and the proper installation of our product are covered in this brochure — requests for this literature will be handled promptly.

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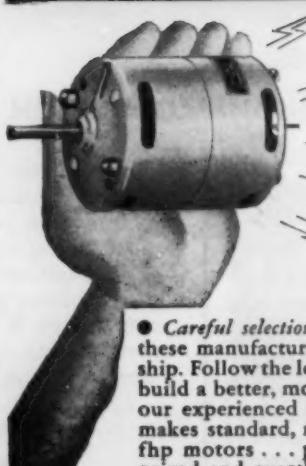

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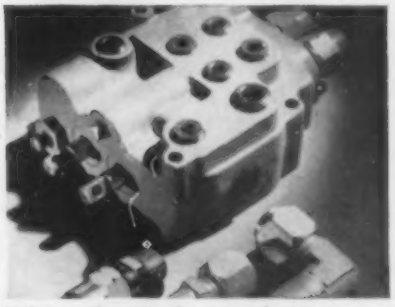
O-ring leaks?

Heat failure was caused by a combination of compound and design problems. Parker field engineer was called. Leaks were stopped . . . and complaints ended.

Compare actual samples. Ask your Parker representative to check your specifications and design. Let him prove how Parker O-rings seal better, last longer.



What other Parker products interest you? *Triple-lok* flare tube fittings? Ferulok flareless fittings? *Hoze-lok* fittings? Hydraulic directional control valves?

. . . then call in your Parker field engineer for help

Having trouble with O-ring failures? Nibbled, worn, battered, leaking like a sieve? Whether your problem is in the basic design or compound, it's time to call a Parker representative.

Parker field engineers are trained trouble shooters. There is one in your area. From Parker you can get exactly the *right* O-ring and gland design for your *specific* application.

Compare Parker O-rings with any other make. You'll find that Parker O-rings are precision-molded of superior compounds. They have been developed as the result of years of experimentation to provide the proper elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures. Laboratory and service tests make sure that all rated characteristics are held.

Call your Parker representative for assistance. Mail the coupon for *free* technical bulletins about O-rings.

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components

RUBBER PRODUCTS DIV.
Section 513-D
The Parker Appliance Co.
17325 Euclid Ave.
Cleveland 12, Ohio

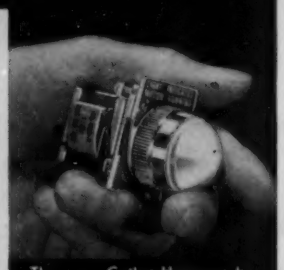
Please send the following bulletins:

- ☐ Silicone Rubber Bul. 5605 B1
- ☐ Materials for O-rings Bul. 5705 B1
- ☐ O-ring Operation Factors Bul. 5705 B2
- ☐ Thermal Properties Bul. 5705 B4
- ☐ Rotary Seal for High Speed Bul. 5705 B5
- ☐ Aircraft Hydraulic Packings Bul. 5712 B1

Name_____
Company_____
Address_____
City_____ State_____

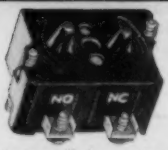
NEW CUTLER-HAMMER
HEAVY DUTY, OILTIGHT
PUSHBUTTONS

The new Cutler-Hammer Pushbutton with contact block measuring only 1 3/32" in depth.



The new Cutler-Hammer Indicating Light with separate winding transformer measuring only 1 3/32" in depth.

New small size contact blocks.
New circuit flexibility.
Better design; better performance; better appearance.



New small size contact block with both electrically and mechanically isolated contacts.

There is nothing to compare with Cutler-Hammer's new line of heavy duty oiltight pushbuttons, selector switches and indicating lights. There is nothing to compare with the new small size contact block which measures only 1 3/32" in depth behind the mounting panel. Nor is there anything to compare with the greater degree of circuit flexibility this new contact block provides. Only *this* has contacts "in parallel," electrically isolated from one another so that you can apply a different voltage on each set, or alternating current on one and direct current on the other. There is nothing to compare in size or design with the indicating light, resistor or transformer type; nothing to compare in visibility with the new Cutler-Hammer indicating light.

So it goes throughout the complete new line. Every type of operator; every type of pushbutton; full range of colors in pushbuttons and indicating lights; new chrome-plated operators for lasting beauty; new design diaphragm for lasting performance. These and many, many other features are described in a new, fully illustrated bulletin. Write for it now. See the complete line at your authorized Cutler-Hammer distributor. CUTLER-HAMMER, Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Partial view of Magcoa H. A. E. treatment facilities

New anodic finishes pave way for wider use of magnesium

Recent developments in anodic finishes have helped to increase the versatility of magnesium and make it suitable for an ever widening range of product uses.

The Dow Chemical Company has developed an anodic treatment known as Dow #17 which offers excellent corrosion protection and provides an excellent paint base.

Another anodic treatment offering excellent corrosion protection and providing an excellent paint base is the H. A. E. treatment, developed by Pitman-Dunn laboratory of Frankford Arsenal. The letters "H. A. E." are the initials of the inventor, Mr. H. A. Evangelides. The H. A. E. coating offers the additional advantage of exceptional hardness and abrasion resistance.

Additional information on finishes for magnesium is available from our engineering department. In fact, whenever light metals can be used for your parts or products, Magcoa engineers can help you design them and Magcoa fabricating facilities can produce them for you. We welcome your inquiry.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

magcoa

CLOSE UP OF TYPE V-1 CADDY TOGGLE CLAMP

CADDY Toggle Clamps are used on the FORD Cleveland Foundry core wash operation in the manufacturing of FORD and MERCURY engine castings.

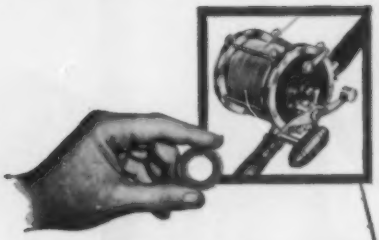
The FORD Foundry turns out castings for both FORD Engine Plants in Cleveland and high production equipment is essential.

Prior to the adoption of the CADDY Toggle Clamps, FORD tested the clamps for 6 months. The key feature in the selection of CADDY was that they maintained uniform clamping pressure throughout the life of the clamp and developed no springing or wobble.

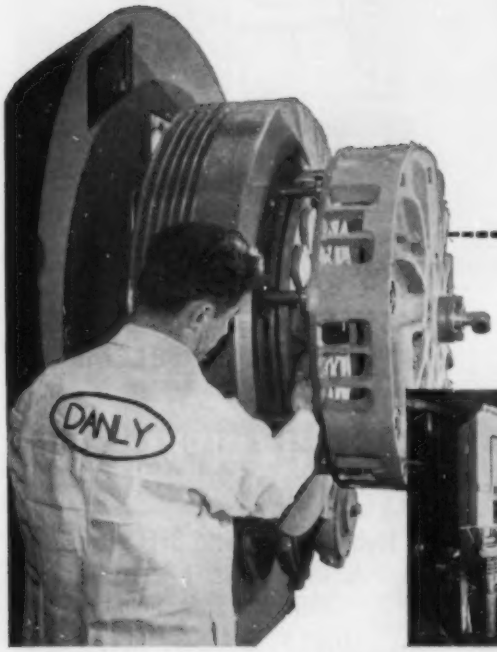
CATALOG ON REQUEST

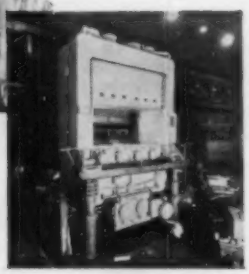
CADDY TOGGLE CLAMPS
Erico Products, Inc.
2070 E. 61st Place • Cleveland 3, Ohio
IN CANADA: ERICO INCORPORATED, 2871 Dundas St., West, Toronto 9, Ontario

Boating a world's record Marlin...



1525-lb. Marlin, the women's world's record, caught by Miss Kimberly Wiss on a Penn Senator Reel with friction drag using J-M Style #600 lining.





or stamping out auto parts...

Two-story high Danly unit for stamping automobile parts using J-M Clutch Disc Inserts.

Equipment can be controlled more efficiently with J-M Asbestos Friction Materials

Johns-Manville Asbestos Friction Materials meet a wide range of applications. Whether you need a tiny brake material for a fishing reel . . . or a rugged clutch facing for a powerful machine press, Johns-Manville can help you.

Precision manufactured, dependable Johns-Manville Friction Materials are available in low, medium and high friction coefficients. These linings and facings are specially engineered to withstand severe shock, maintain friction stability under critical temperatures, provide smooth action at a low rate of wear. If your requirements demand a friction material that must be custom-made for a special use . . . the Johns-Manville Research facilities are available to help develop that just-right formulation.

Whatever your friction material problem, the J-M Friction Materials Specialist is at your service. Or, write for reference booklet that contains a complete description of J-M Friction Materials and a handy selector chart. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

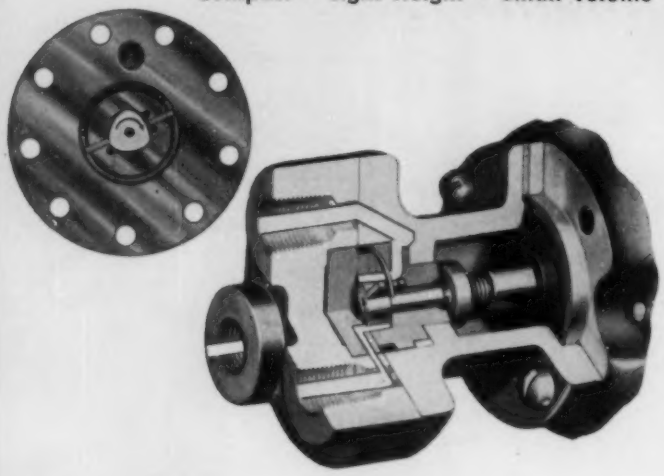
Johns-Manville INDUSTRIAL FRICTION MATERIALS

WELDON

FLUID METERING PUMPS

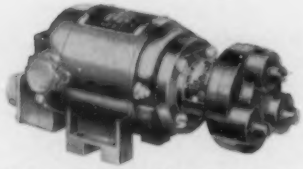
Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.

Compact • Light Weight • Small Volume

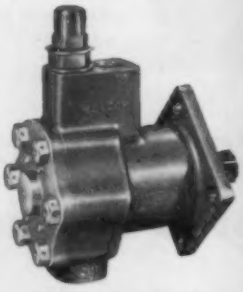


IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



STYLE A—Single inlet double outlet type aircraft pump



STYLE F—Engine driven fuel pump

STYLE C—Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

FOR RELIABLE ASSISTANCE WITH SOLDER AND FLUX PROBLEMS . . .

SEE THE ALPHA® MEN

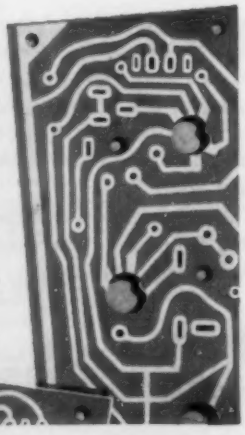
highly trained field SPECIALISTS ALWAYS available in YOUR TERRITORY to give you QUALIFIED ASSISTANCE.

ALPHA METALS, INC.
68 Water St., Jersey City, N. J.

ALPHA QUALITY CONTROLLED PRODUCTS BY SPECIALISTS in Solders, Fluxes, Tin & Lead Products FOR OVER 50 YEARS.

offers the facilities of a modern well equipped metallurgical laboratory, competent research staff and trained field specialists to help you solve

PRINTED CIRCUIT FLUX or SOLDER PROBLEMS



For You..."Right-Now" Help From an Emerson-Electric Motor-Drive Specialist

What kind of motor-drive help do you need—now or later? If it has anything whatever to do with appliance motors, here's your man—with a background of 65 years of specialized experience in power drives, he can give you valuable on-the-spot help.

An Emerson-Electric motor-drive specialist will start at the beginning, or idea stage, of your problems—will stay with it through every phase of development, test and application stages—will work closely with your engineering and management personnel on any product or sales improvement you have in mind.

Call an Emerson-Electric motor-drive specialist . . . even if you have no immediate problem, he'll be glad to confer with you. He may be able to make a suggestion you'll find valuable. No obligation, of course.

Emerson-Electric supplies motors for appliances and equipment principally in these classifications: Oil Burner • Blowers • Unit Heaters • Water Circulators • Air Conditioning • Washers • Driers • Ironers • Garbage Disposers • Refrigerators • Freezers • Water Pumps • Air Compressors

Emerson-Electric
of St. Louis • Since 1890

Write THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MO., for bulletins listed below.

- ☐ M 4023-A Capacitor-Start
- ☐ M 4023-B Split-Phase
- ☐ M 4023-C Integral
- ☐ M 4023-D Fan Duty
- ☐ M 4023-E Oil Burner
- ☐ M 4023-F Jet Pump
- ☐ M 4023-G Blower

BRANCHES: New York 7, N. Y., 11 Park Place • Chicago 23, Ill., 1623 S. Pulaski Road • Syracuse, N. Y., 209 Oakley Drive • Detroit 7, Mich., 1375 E. Jefferson Ave. • Los Angeles 42, Calif., 5415 York Blvd. • Davenport, Iowa, 617 Brady St. • Cincinnati 11, Ohio, 2917 Ratterman Ave.

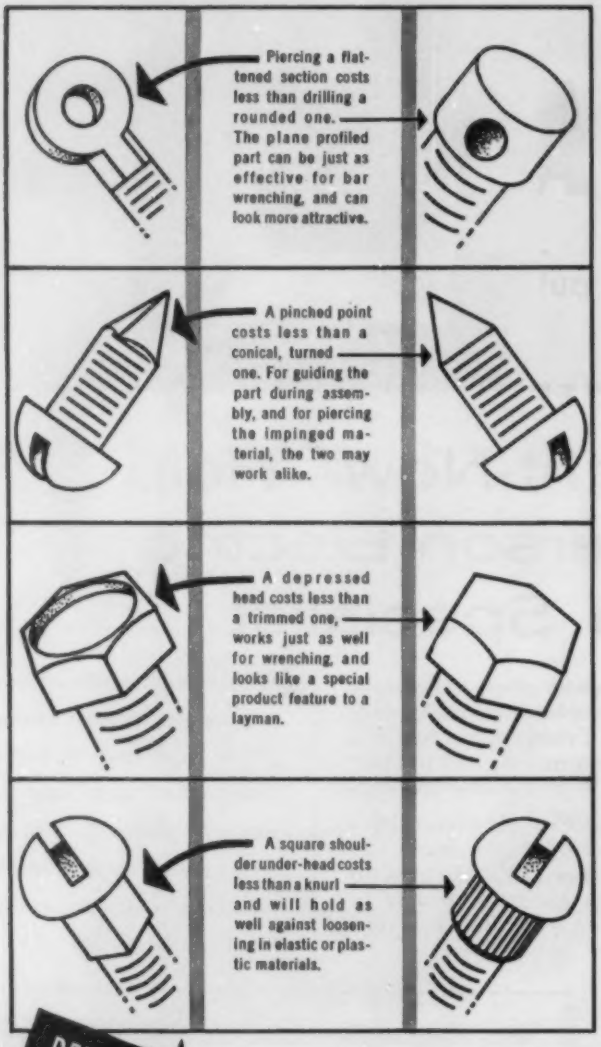
HOW TO

SQUEEZE PENNIES

OUT OF

UPSET SPECIALS COSTS

Specially designed upset products are solving thousands of problems. Dozens of design pointers on them are yours for the asking. Send us your sketches, prints, finished products for suggestions.


Piercing a flattened section costs less than drilling a rounded one. The plane profiled part can be just as effective for bar wrenching, and can look more attractive.
A pinched point costs less than a conical, turned one. For guiding the part during assembly, and for piercing the impinged material, the two may work alike.
A depressed head costs less than a trimmed one, works just as well for wrenching, and looks like a special product feature to a layman.
A square shoulder under-head costs less than a knurl and will hold as well against loosening in elastic or plastic materials.

REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

QUALITY PROMCO BRAND

A HALF CENTURY OF MACHINE SCREWS AND SPECIAL FASTENERS

WRITE FOR OUR CATALOG

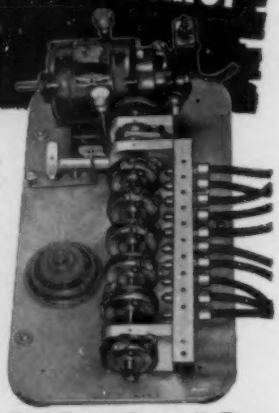
THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.

THIS CLEVER, DEPENDABLE

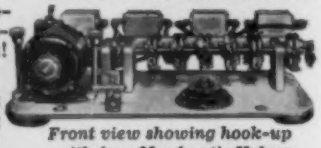
Electro-Pneumatic Timer

Controls Intricate Work Cycles . . .



This simple but astonishingly ingenious unit distributes air pressure to air-operated cylinders, presses, hammers, work feeders, clamping fixtures, chip blowers, work ejectors . . . each independent as to start, duration and end of cycle. Simply connect up 6, 12 or more cylinders in numerous sequences from 2½ to 33½ seconds. *You need this inexpensive* Mead Electro-Pneumatic Timer for cost-saving automation jobs!

No. 6 Electro-Pneumatic Timer



Front view showing hook-up with four Meadmatic Valves

Write Factory or Nearest Mead Representative For Bulletin PE-95

Write for our cost-saving catalog. Or let the Mead Man show you.

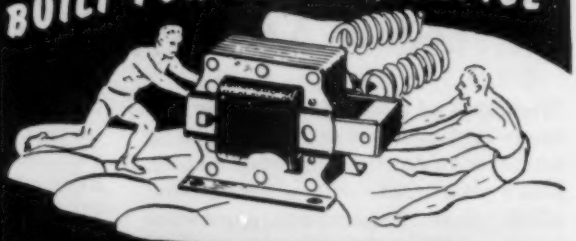
(See Volume III Thomas' Register for nearest distributor's address, phone number.)

MEAD SPECIALTIES COMPANY

4114 N. Knox Ave., Dept. PE-95, Chicago 41, Ill.

PATHFINDER IN AIR POWER AUTOMATION

BUILT FOR TOUGH SERVICE



ALL TYPES • ALL SIZES

Dormeyer MACHINE TOOL SOLENOIDS

Dormeyer offers you the widest variety of solenoids available to industry. Engineered to your specifications from finest quality materials, they outlast equipment life.

Records show Dormeyer Solenoids in operation for over 17 million cycles are still operating as smoothly as the day they were installed! You can get this same rugged performance for your application. Prompt delivery on any quantity.

Send specifications for prompt estimate—no obligation. Request catalog.

DORMEYER INDUSTRIES

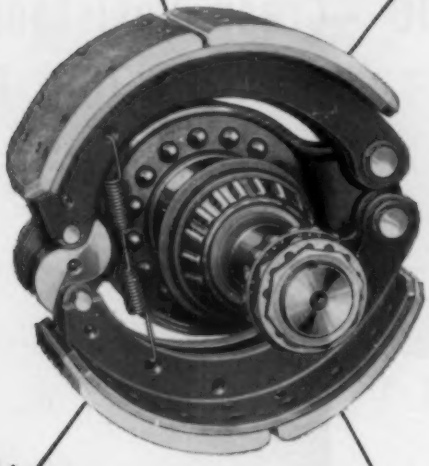
FACTORIES IN CHICAGO AND KENTLAND, INDIANA

3414 MILWAUKEE AVENUE • CHICAGO 41, ILLINOIS

IF IT MOVES WE CAN STOP IT!

TDA BRAKES

...for every industrial or automotive application where braking is required!



P SERIES POWER BRAKES

designed for heavy-duty automotive service

These rugged, heavy-duty power brakes are designed to give longer troublefree service on trucks, truck-tractors, trailers, buses, trolley-coaches and industrial and road equipment.

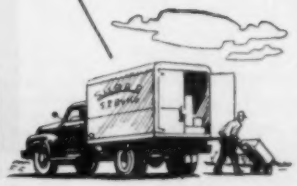
Superior design has made Timken-Detroit's "P" Series brakes the undisputed choice of leading vehicle manufacturers everywhere. Friction and heat are reduced sharply, cutting the biggest cause of brake wear. Other important features of the "P" Series brakes offer increased economy and performance for operators.

"P" Series power brakes are available in a complete range of capacities and sizes. Either air or hydraulic action . . . to meet every operating need.

For additional information . . . with expert consultation, contact the Timken Brake Division. Complete details and specifications on the "P" Series brakes are available. And, a staff of highly experienced engineers can assist you with any brake problem that you may have.

Easy accurate brake adjustments

Slack adjusters permit quick, simple adjustments. When adjustment is made, spring-loaded lock automatically engages adjustment screw to prevent screw backing off during service.



Cooler running

Open-type, malleable iron brake spiders eliminate air pockets and assure adequate internal ventilation for cooler running.

Constant Lift "S" Type Cam

Constant lift "S" type cam assures uniform application of brake shoes for maximum sensitivity and controllability.

Longer liner life with "Econoliner"

Timken Detroit *Econoliners* are tapered to provide greater strength and thickness at the center where wear is greatest.

Better brake drums

Sturdy, rugged brake drums are designed to supply maximum rigidity with rapid heat dissipating ability.

TIMKEN Detroit BRAKES

TIMKEN DETROIT BRAKE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ASHTABULA, OHIO

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Utica, New York • Ashtabula, Kenton and Newark, Ohio
New Castle, Pennsylvania

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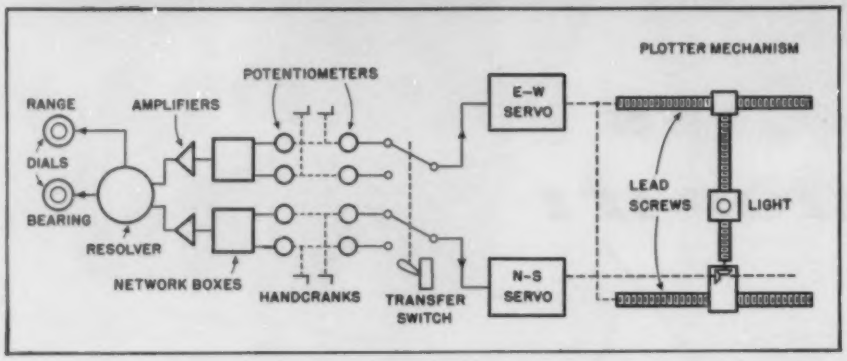
SINCE 1915 LEADERS IN AUTOMATIC CONTROL



Continuous Distance and Bearing Solutions with Unique Plotter-Resolver System

Problem: Determine automatically and continuously the distance and relative bearing of any two points on a map.

Ford Instrument's Solution: A combination of two standard components – a map plotter and an electrical resolver.

Result: Equipment can operate with maps up to a yard square – whose scale varies over a wide range. This means real flexibility because it does not restrict plotter just to maps – since photographs – even sketches can be used.

Here's how it works: The plotter proper has a smooth unobstructed glass top on which the map is placed. Under the glass there is a light traveling on screws. The screws are driven horizontally (E-W) and vertically (N-S) by servo motors actuated by a computing mechanism. The position of the light on the plotter is controlled by four handcranks. Two of the handcranks are used to position the light under the first point; a transfer switch is then thrown and the other two handcranks used to position the light under the second point. The map coordinates of the two points are algebraically added in two network boxes, the resultant voltage from the network boxes being the N-S and E-W distances between the two points. The resolver converts these two distances into range and bearing, which are indicated on two dials. Such a technique results in astounding accuracy. In a computer employing this principle, the maximum range error is on the order of one yard in a thousand, and the maximum bearing error is 10′. The average errors are about half the maximum.

If you have a problem in any phase of automatic control, it will pay you to discuss it with Ford engineers.

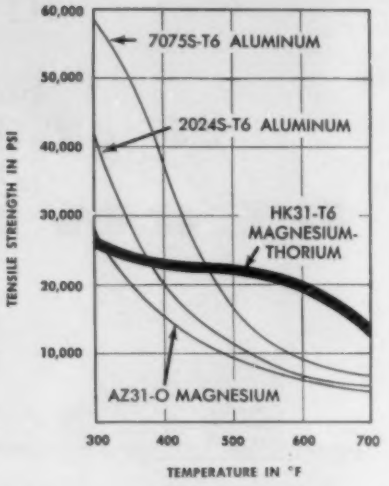
Visit our Booth #15 at 1st Annual Trade Fair of Atomic Industry— Sept. 26-29, Washington, D. C.

70

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

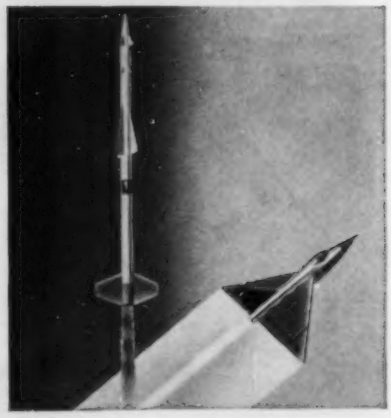
ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

TENSILE STRENGTH AT ELEVATED TEMPERATURES



Creep Resistance at 300°-700° F.

In this temperature range, use the thorium-containing alloys of magnesium. They are the only satisfactory metals which combine creep resistance with good strength and light weight.



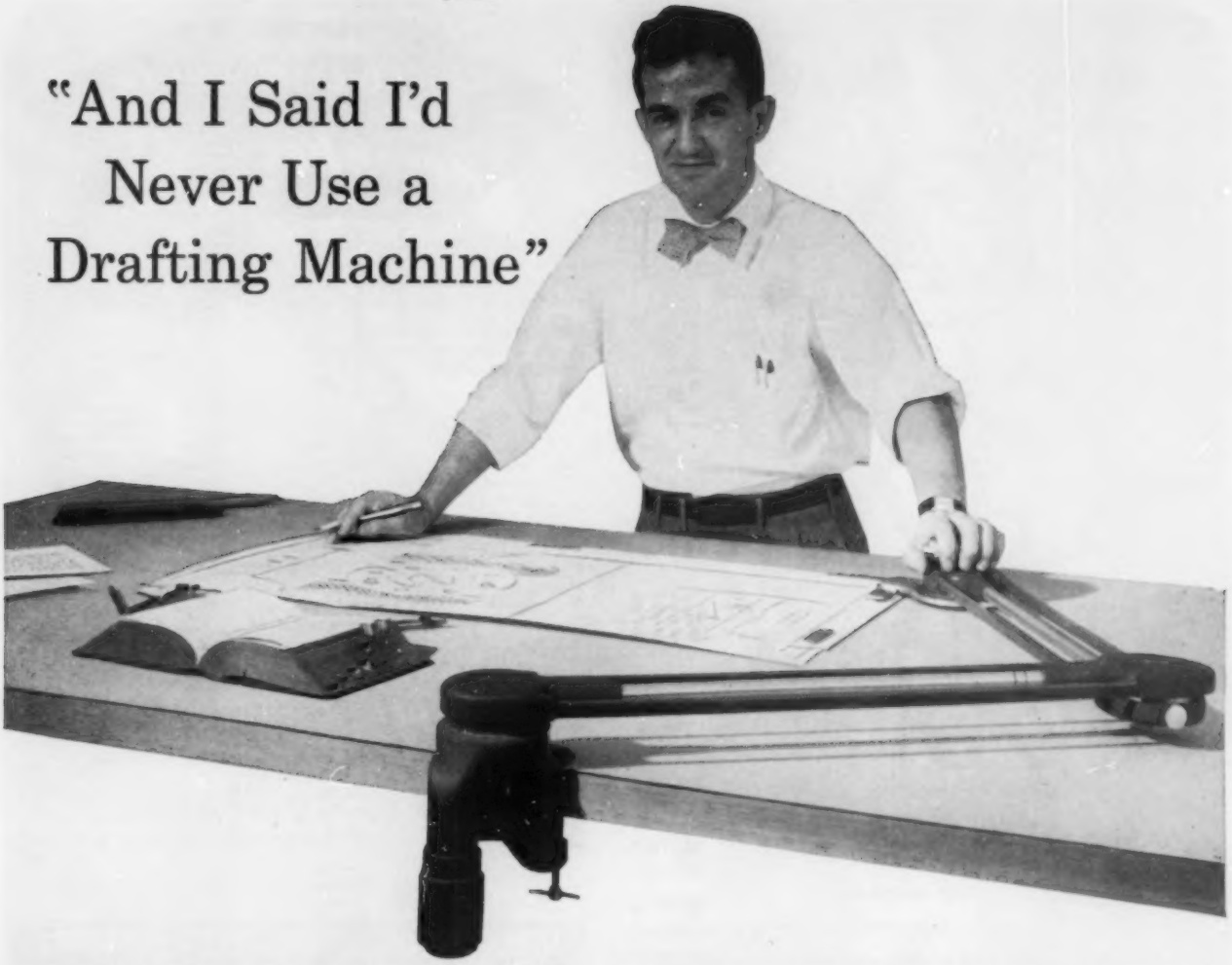
For designers of high speed jet planes, rockets, and guided missiles, this solves a problem. Formerly it was thought necessary to use heavy materials. They are less satisfactory than these magnesium alloys.

Formerly available in the form of castings only, thorium-containing magnesium alloys now come in rolled sheet. B&P's mill produces this sheet.

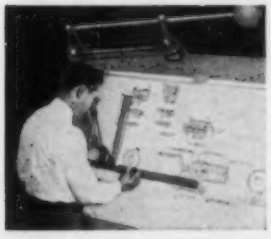
B&P engineers will help you redesign in magnesium. B&P offers the magnesium industry's most complete facilities for fabrication and assembly. Your inquiry will bring a descriptive booklet.

BROOKS & PERKINS, Inc.
LIGHTNESS . . . PLUS!
1956 WEST FORT STREET
DETROIT 16, MICH.

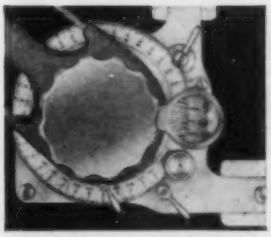
"And I Said I'd Never Use a Drafting Machine"



"That Was Before I Tried a Bruning Equipoise Drafter!"



Bruning Counterbalanced Drafters and Bruning Track Drafters provide fast, easy, accurate drafting on vertical boards and on extra-large drawings.



Bruning Equipoise Drafters are available with either the Civil Engineer protractor head, shown here, with its special azimuth scale, or the Standard protractor head.

Take a tip from an increasing number of draftsmen who, perhaps like yourself, were reluctant to try any drafting machine or had been disappointed in a conventional type drafter. These men now report: Bruning Equipoise Drafters cut drafting time over conventional equipment up to 40% on most jobs, up to 50% on some structural drawings — beat any other drafting machine they ever tried.

But prove it to yourself! See how fast you'll work with one precision instrument combining T-square, straightedge, triangle, protractor, and scales. Feel how the patented Equipoise mechanism eliminates any drift from gravity, literally makes the drafter "float" into place. Find how easy it is to rotate, turn, and lift this drafter — all with the left hand. At the same time, operate the Touch Control button with your left thumb to set the drafter automatically at any of 24 commonly used 15-degree increment angles. Don't overlook the special scale lock that makes it easy to change the scales, holds the scales rigid.

Your own test will convince you of the superiority of a Bruning Equipoise Drafter. Mail coupon today!

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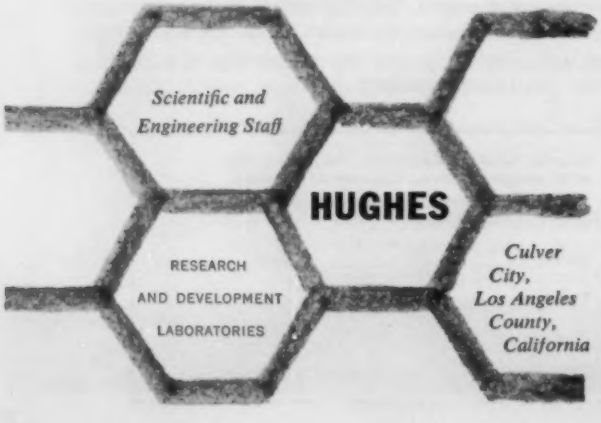

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for "fixed" fastenings for "hard-to-reach" or blind assemblies. They wear longer, hold tighter, give greater customer satisfaction.

See how leading appliance manufacturers get lower cost fasteners into inaccessible places.

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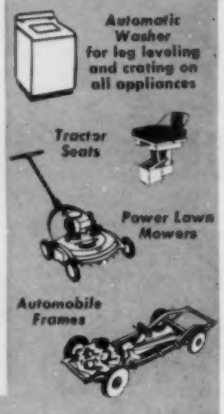

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With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly enhanced.

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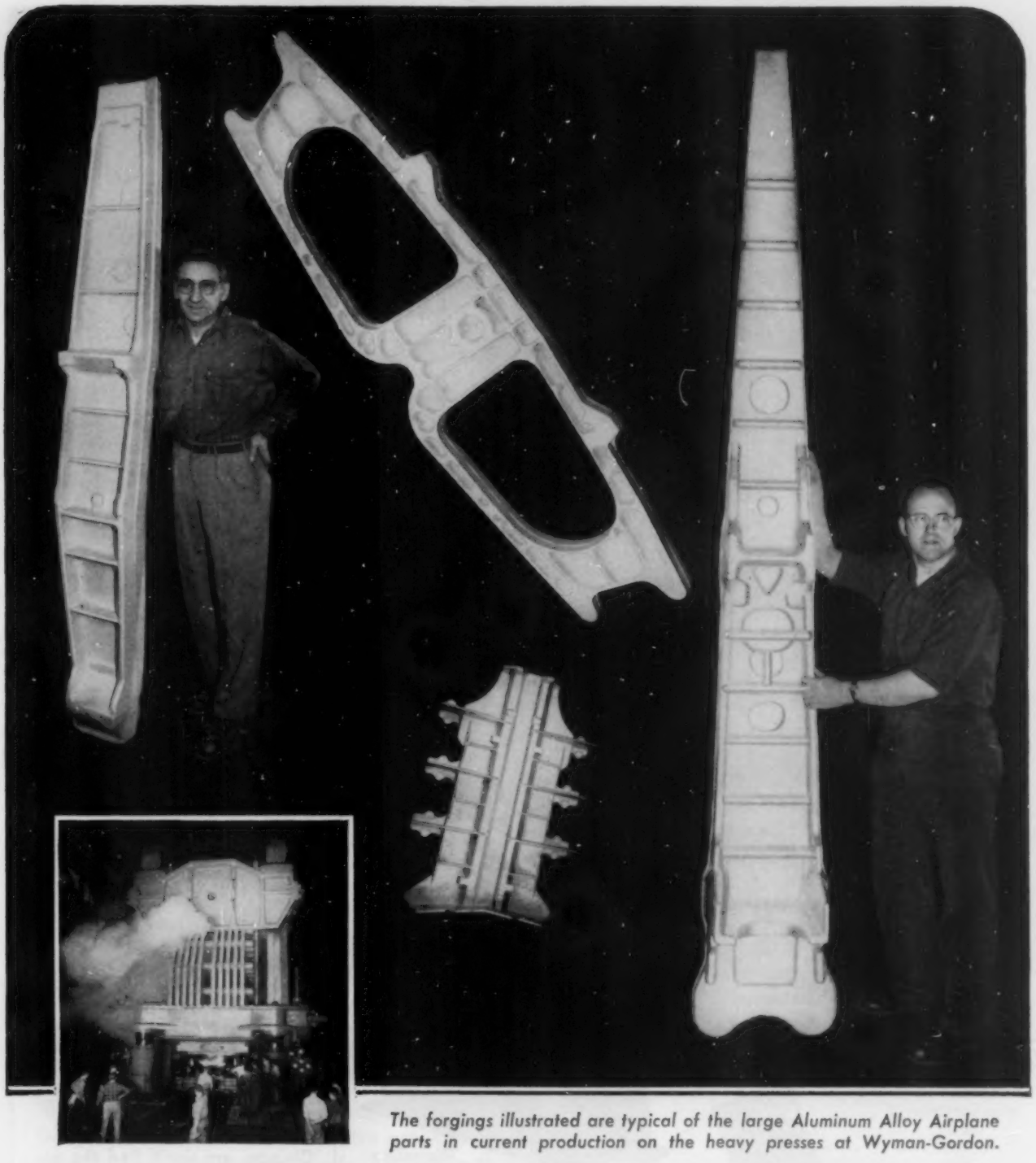

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A new era in the art of forging has been demonstrated as production goes forward on this 35,000-ton closed die forging press. Larger forgings with thinner sections and closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by — Keeping Ahead of Progress.

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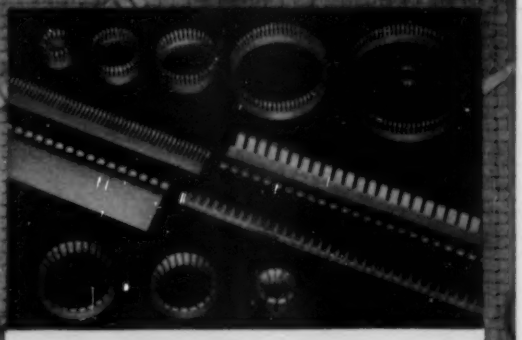

1-S Beryllium copper finger contact strips and contact rings combine higher elastic performance, accuracy of contour and choice of three finishes. Precision methods extended into mass production, eliminate hand adjustment of assembly . . . reducing final costs.

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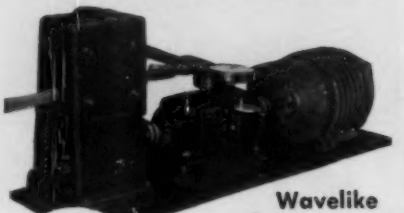

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* *memory-aiding.* See article on "Numbering Systems," p. A16, '55 issue.

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FACTORY ADJUSTED
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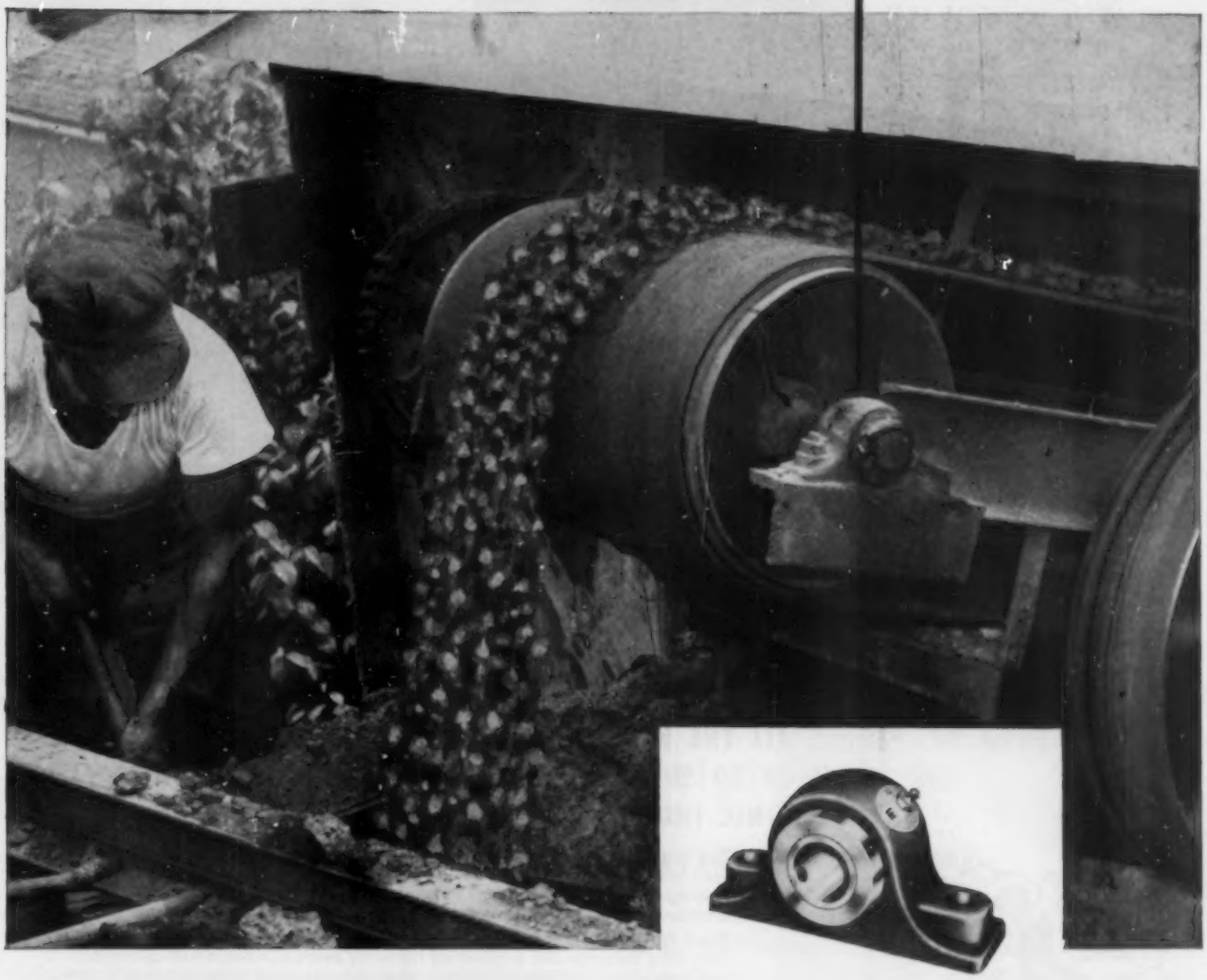

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Extra measures are taken to build superior quality into Dodge-Timken Bearings; and extra precautions are taken to keep that quality *intact*—from the factory to distributor to you to your machines.

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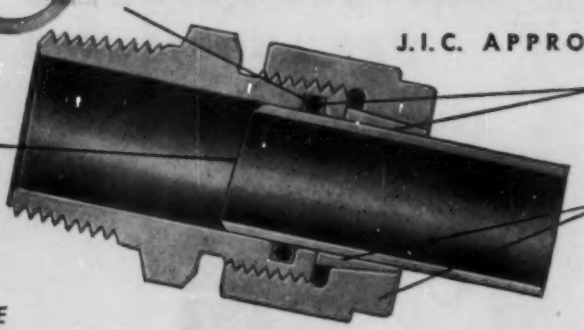
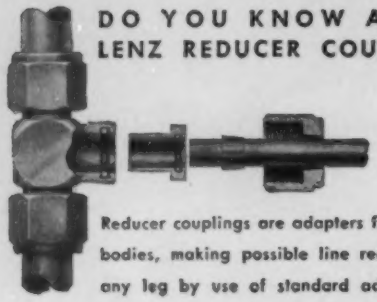
NO CONCENTRATION OF STRESSES DUE TO FLARES OR FERRULES FOR TUBE FAILURE



SEAL AND GRIP ARE SEPARATE

HELD BY FRICTION GRIP OF THESE TWO

NO EXACT TUBE LENGTH NECESSARY



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You'll find all Stewart-Warner electronic industrial balancers compact, extremely accurate and engineered for many years of trouble-free operation. You'll also find that Stewart-Warner electronic industrial balancers incorporate extreme minimum and maximum ranges... in each individual balancer... that often require several balancers of other makes.

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- ½ lb. to 25,000 lb. weight range
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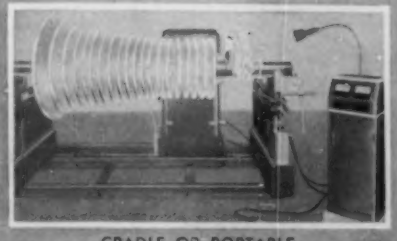
- From $1295 including operator training

These are established capacities. Should your requirements exceed the above specifications, please write us stating your exact balancing problem.



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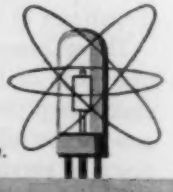

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*Approximately 50% lower in initial cost than other advertised balancers.

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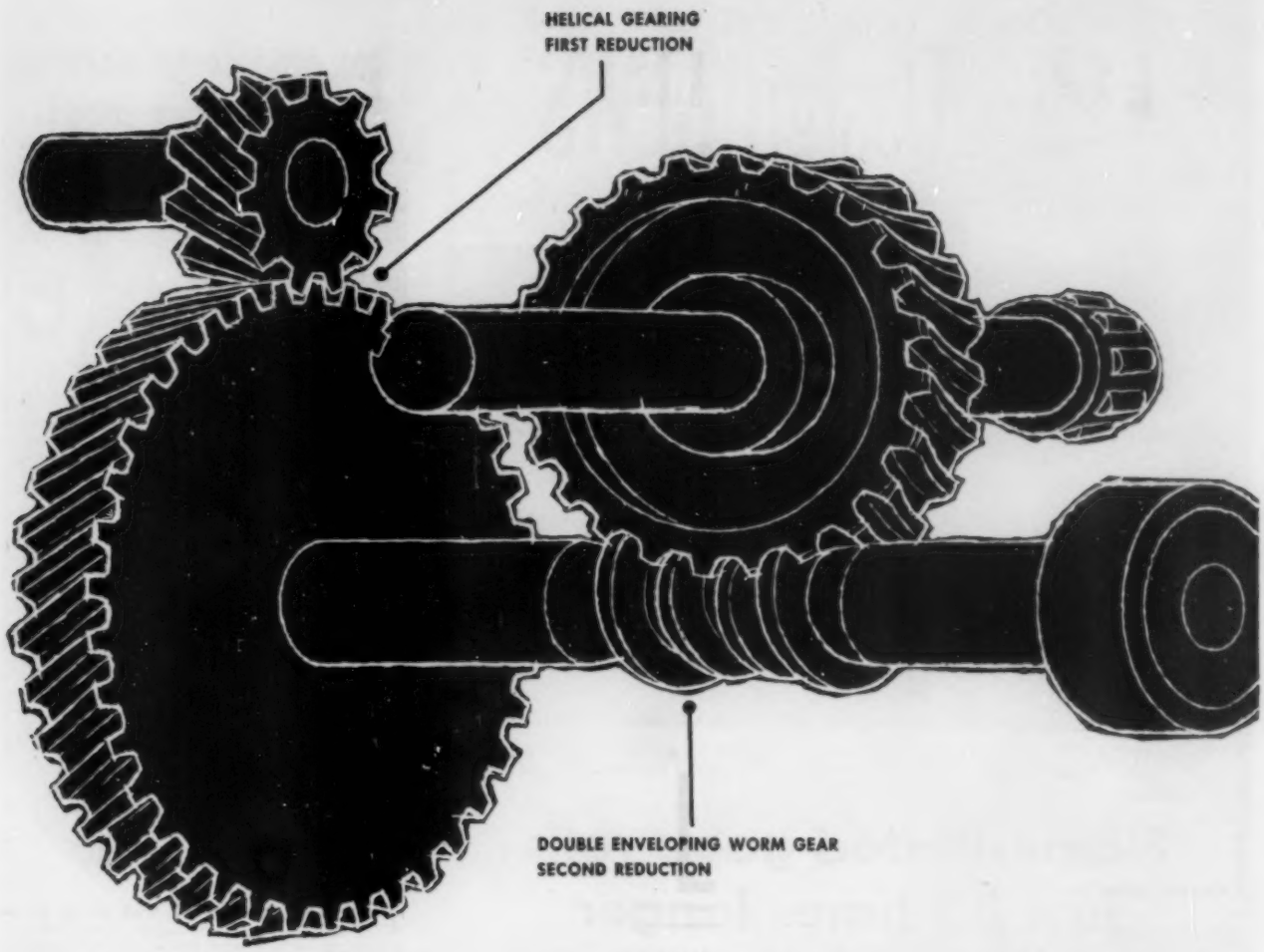

How Westinghouse new right-angle gearmotor delivers 32% more power

With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

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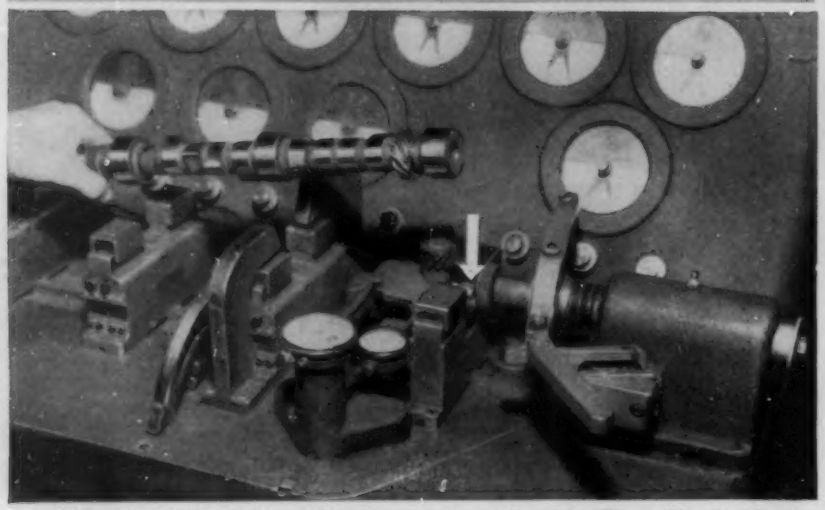
Westinghouse

FLP SERVICE MARK

Design NEWS

News of Another Design Problem Solved With Flame Plated Tungsten Carbide Coatings.



The master rolls of this camshaft gage (see arrow) have been Flame-Plated with tungsten carbide. Service life has been increased 32 times.

Flame-Plated gage rolls last 32 times longer

The short service life of master rolls in a special camshaft gage posed a knotty maintenance problem for a large automotive manufacturer recently. It was discovered that a groove would appear in the regular high-speed steel rolls after gaging 2400 pieces in the course of two days' operation. This situation meant that the rolls had to be changed frequently and, what was more important, the possibility of passing sub-standard parts was increased.

This problem was solved by having the steel master rolls Flame-Plated with a coating of tungsten carbide. The hard tungsten carbide coating resisted wear to such a high degree that no grooving was evident after 78,000 pieces . . . three months' work . . . had been passed through the gage. The result? Less down time and a high degree of accuracy over a long period of time.

Flame-Plating is LINDE's process performed in LINDE's plants for depositing a tungsten carbide coating on metal parts. Finished or semi-finished parts made of most metals can be Flame-Plated without distortion as the temperature of the part being plated does not exceed 400 deg. F. The coating may be used in as-coated condition (similar to fine emery paper) or ground to a fine finish.

For the full Flame-Plating story, call your nearest LINDE office today or write for your free copy of the Flame-Plating Booklet.

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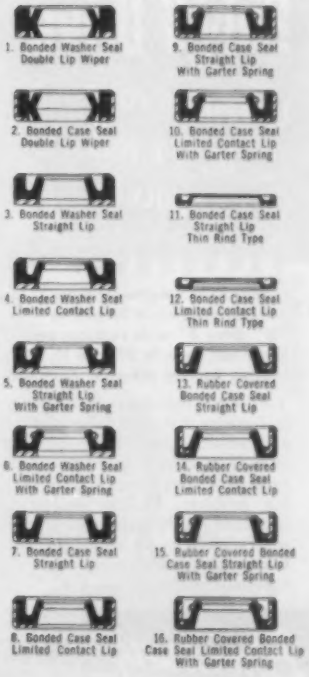
1. Bonded Washer Seal Double Lip Wiper
9. Bonded Case Seal Straight Lip With Garter Spring
2. Bonded Case Seal Double Lip Wiper
10. Bonded Case Seal Limited Contact Lip With Garter Spring
3. Bonded Washer Seal Straight Lip
11. Bonded Case Seal Straight Lip Thin Rind Type
4. Bonded Washer Seal Limited Contact Lip
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
5. Bonded Washer Seal Straight Lip With Garter Spring
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6. Bonded Washer Seal Limited Contact Lip With Garter Spring
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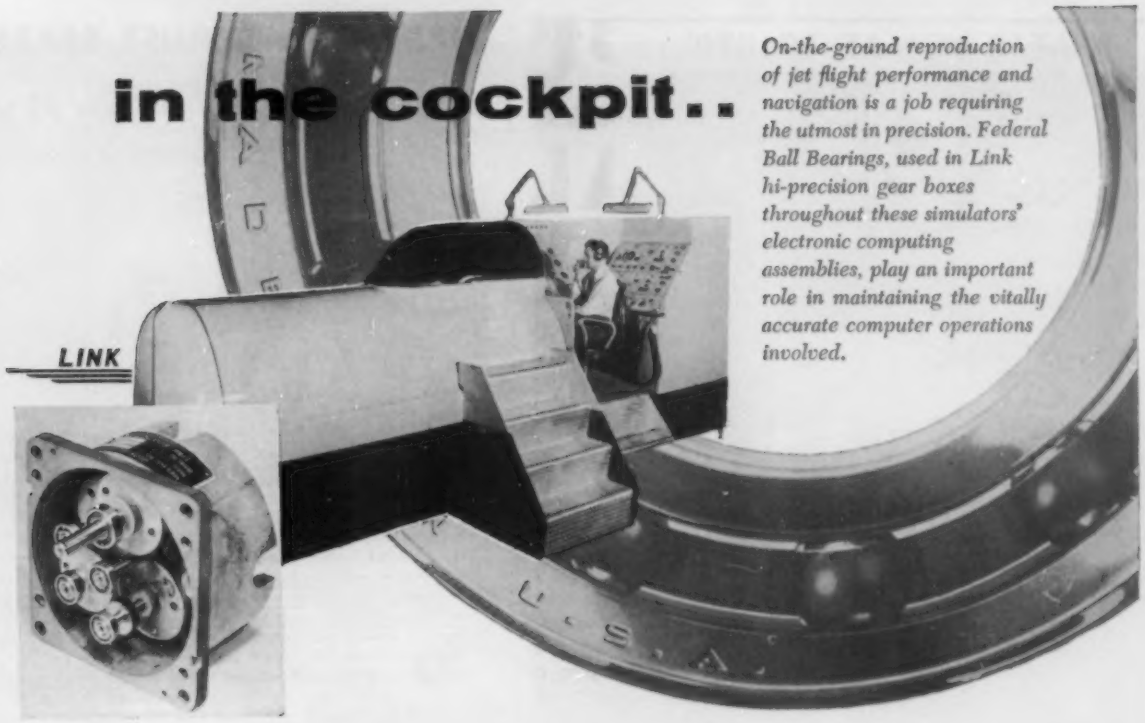

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Automation and Bristol Through-Broached Screws cut assembly time at Burroughs

BURROUGHS, DETROIT, reports that Bristol patented Through-Broached Socket Screws, hopper-fed to a power screwdriver, cut in half the time required to insert set screws in critical stop dogs for their Sensimatic Accounting Machine.

THAT'S NOT ALL. Machine-fed Bristol screws not only eliminate a tedious hand operation, but also cut loss of screws due to dropping and cross threading.

HOPPER-FEED is no problem with the double-ended, symmetrical Bristol Through-Broached Socket Set screw. It has all the holding power of a standard socket set screw but, to facilitate machine assembly, the socket is broached all the way through so it can be inserted from either end.

Write to The Bristol Company, Socket Screw Division. A.5.5

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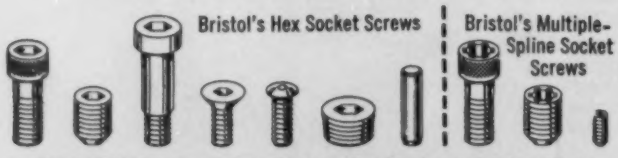
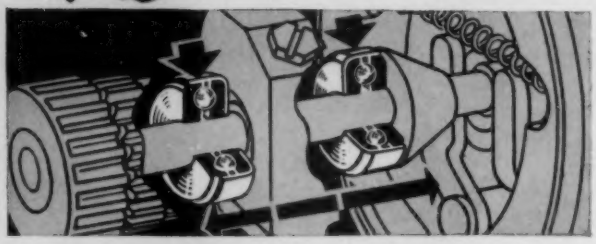


Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

HARTFORD THRUST BEARINGS

help to give the new **ROYAL**
ELECTRIC TYPEWRITER
"The Light Touch"



The Royal clutch unit depends upon Hartford Thrust Bearings to achieve smooth, instantaneous response to a critical adjustment on the carriage return. *Yoke pressure is applied to the clutch nose through the thrust bearing, transmitting the yoke pressure and driving shaft speed to the clutch nose instantaneously without retarding friction.* It is just one of several important *Hartford* bearing applications in every Royal typewriter. If you have a bearing problem that requires precision balls, retainers or bearings made to your specifications, it will pay you to consult with *Hartford* engineers.

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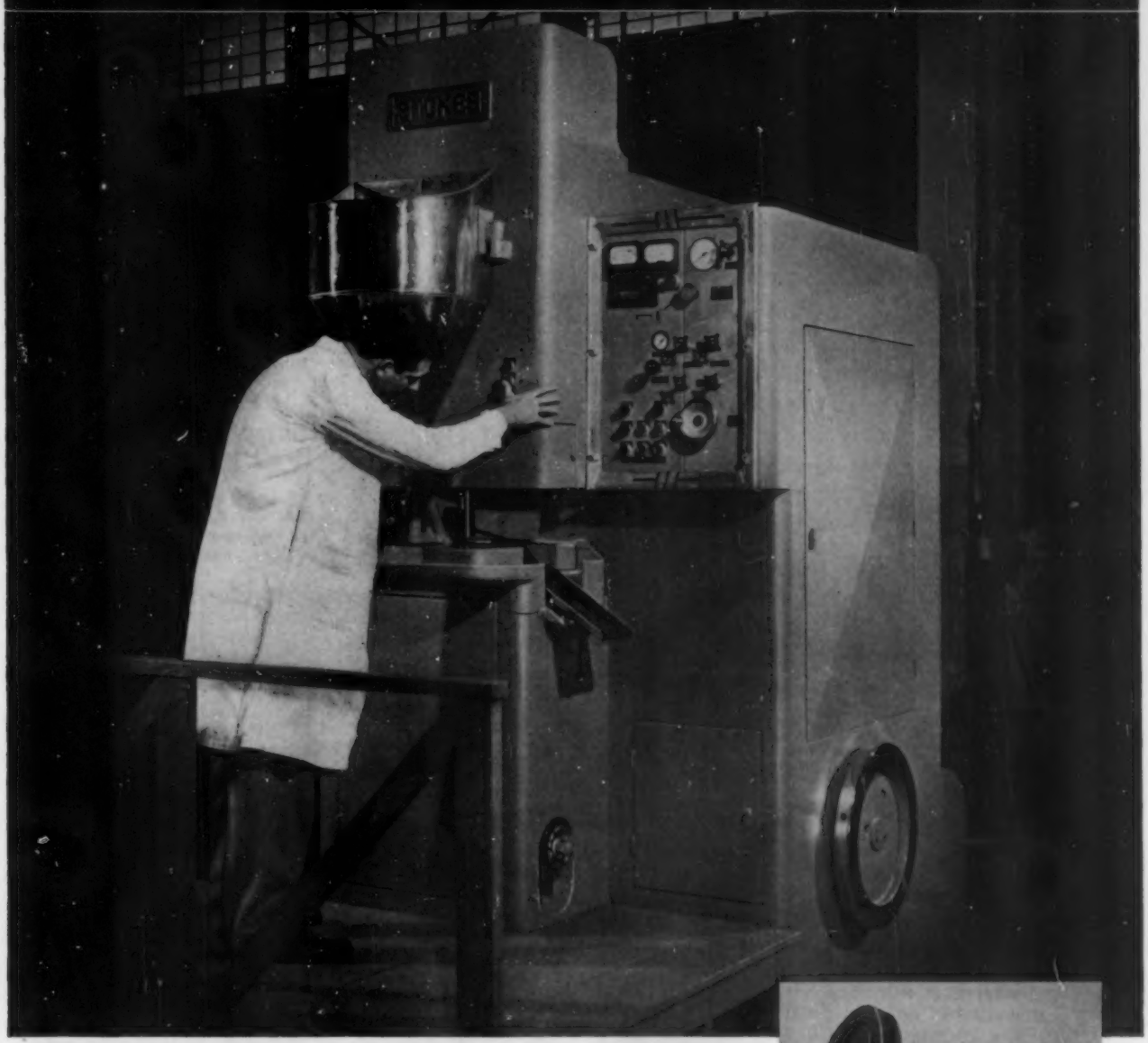
212-47 JAMAICA AVE., QUEENS VILLAGE 28, N. Y.

NEW versatile STOKES powder metal press



A new 50-ton multiple-motion press offers increased economy to powder metal molders

Here is a powder metal press so new, so radically different from anything in the field today that it presents entirely new possibilities for efficient industrial compacting. With its simplified tooling and fast operation, the 640 press outdates all other designs; makes possible the application of powder metal to the production of parts for which the process has never before been considered economical.

The Stokes Model 640 is a completely new design, based on an intimate knowledge of the industry's requirements. It represents the latest achievement in Stokes 35-year experience in the design and manufacture of presses specifically for powder metallurgy.

For example, the 640 press is the first to give full, *50-ton simultaneous breakaway* on multiple lower punches, important in successful ejection of complex parts; *centralized controls*, for easy, fast set-up and operation; *independent adjustments* of all press actions while the machine is running; *direct-reading handwheel calibrations*, that eliminate guess-work on settings, permit exact records for each piece produced.

If you are now compacting powdered metals or are investigating how this economical process can be applied to your production, you should know about the many exclusive features of the Stokes Model 640 press. Write for Bulletin 670.

F. J. Stokes Machine Company
Philadelphia 20, Pa.

The pieces shown are typical of parts for which the Model 640 press is particularly well suited. Difficult parts like these and pieces with double hubs, multiple levels and thin flanges all can now be made economically on the Stokes Model 640 press.

STOKES

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If ENGINES are in the Picture . . . WISCONSIN would like to be on YOUR TEAM

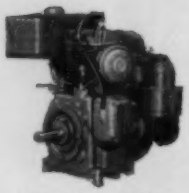
It takes a lot of things, a lot of people, a lot of skills and experience . . . and *sound engineering* to build any kind of a machine. And above all, it takes *team-work* . . . not only in your own plant but also with the engineering departments of your *actual* or *potential* component suppliers.

Here at Wisconsin Motor we have available a great deal of specialized know-how in the design and manufacture of Heavy-Duty Air-Cooled Engines for hundreds of original equipment applications. Our engineers would like to place this experience and broad knowledge of engine design and performance at your disposal if your equipment can utilize engine power within a 3 to 36 hp. range.

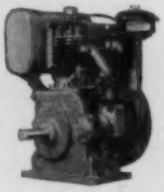
It is axiomatic that no machine is any better than the power that drives it. And it is on this premise that Wisconsin Engine progress has been nothing short of phenomenal since the introduction of these heavy-duty air-cooled engines more than twenty years ago. Today our Original Equipment customer list reads like a Blue Book of American "blue chip" Industry . . . including, also, hundreds of smaller manufacturers of quality-built machines.

When you specify "Wisconsin" you get tapered main bearings, four piston rings on even the smallest models, extra-long connecting rods, rotary type high tension OUTSIDE magneto with Impulse Coupling for fast starts at low cranking speed, plus efficient AIR-COOLING from sub-zero to 140° under average operating conditions.

Why not "team up" with Wisconsin? Tell us about your problem.



4-cycle single cylinder models, 3 to 6 hp.



Single cylinder models 6 to 9 hp.

2-cylinder models 7 to 15 hp.

V-type 4-cylinder 15 to 36 hp.

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Quick, simple insertion . . . Drill Hole and Drive Stud with a single blow.

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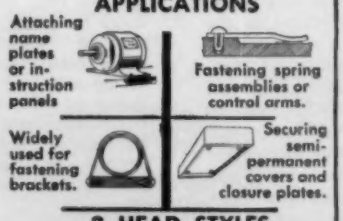
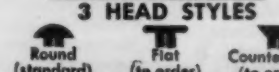

Attaching name plates or instruction panels
Fastening spring assemblies or control arms.
Widely used for fastening brackets.
Securing semi-permanent covers and closure plates.

3 HEAD STYLES



Driv-Lok Studs save time and reduce costs in fastening name plates, covers, brackets, panels, etc, to heavier sections and for countless other applications involving light-to-heavy member fastening. Once installed, Driv-Lok Studs will not vibrate loose or fall out — yet they can be easily removed without damage to components. Made in 3 head styles. Write for illustrated catalog sheet, prices and samples.

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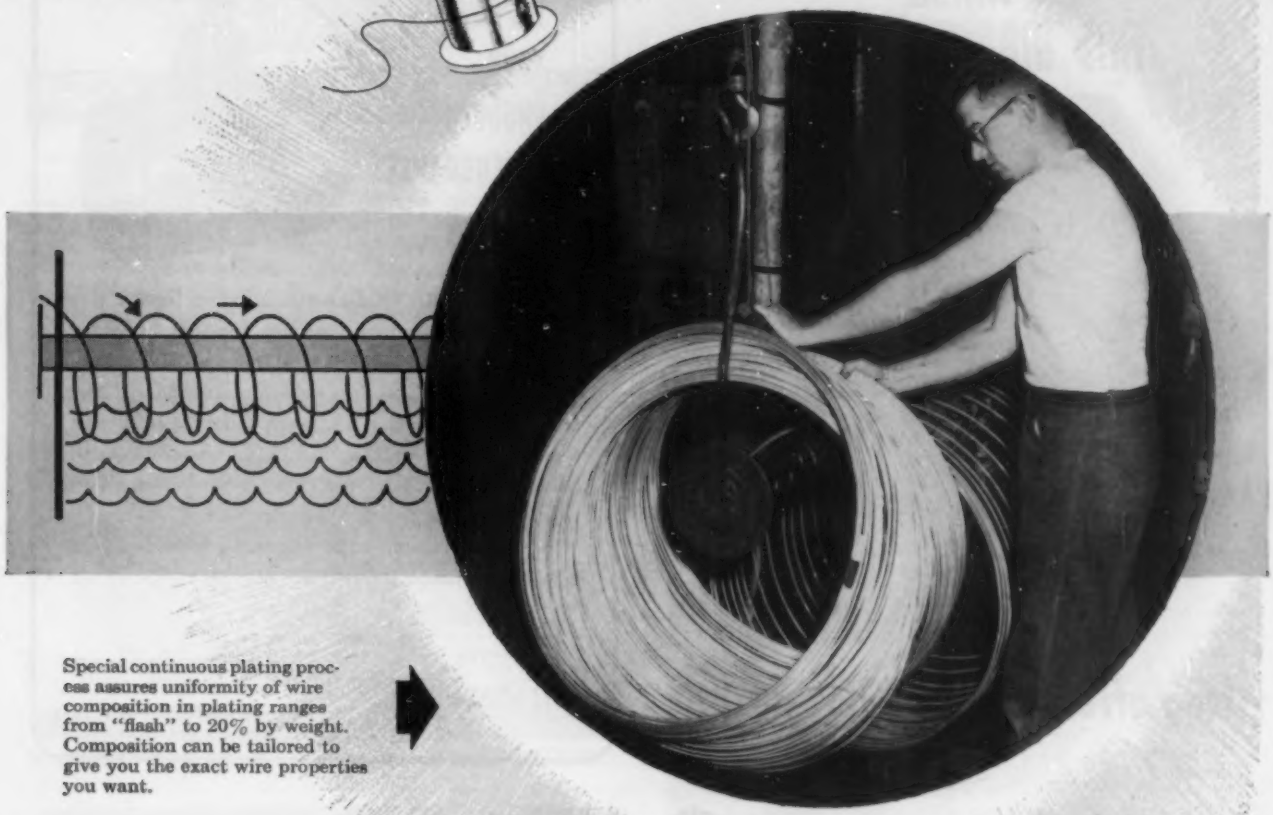

Special continuous plating process assures uniformity of wire composition in plating ranges from "flash" to 20% by weight. Composition can be tailored to give you the exact wire properties you want.

What special properties do you want in a plated cold-drawn wire?

CAN a fine, cold-drawn wire with special properties help you improve product design or manufacture? Sylvania has "made-to-order" facilities to meet your exact requirements. Whatever your interests in wire, for mechanical or electrical use, Sylvania is equipped to produce a composite wire tailored to your product or production needs.

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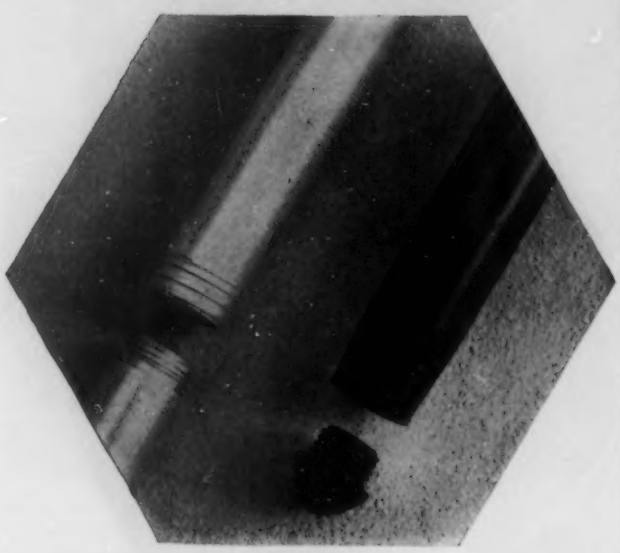

Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail this coupon today.

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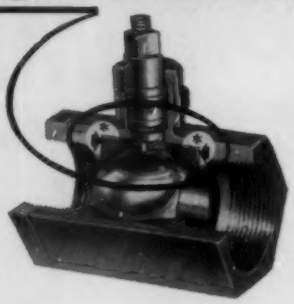

New JAMESBURY Double-Seal ball valves improve your product performance due to round flow, minimum friction loss and extra long life. Available in naval bronze, aluminum, stainless and carbon steel .... Seats and seals available Buna-N, Hypalon, Silicone or Teflon.... For high vacuum and pressures of 300, 600 or 1200 psi in either direction .... Low torque quarter turn operation .... Sizes from ¼" to 2" .... Handles a wider range of liquids or gases than any other valve.

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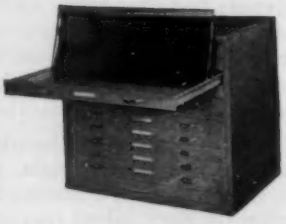

PLAN FILE WITH HINGED COVER

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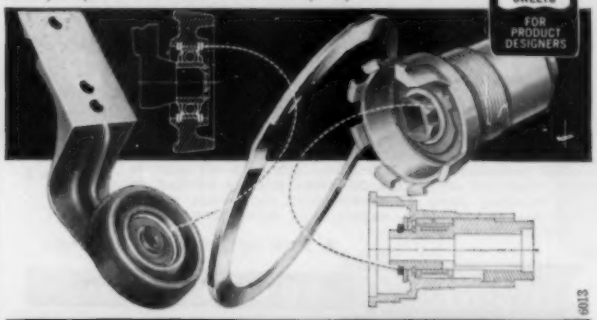

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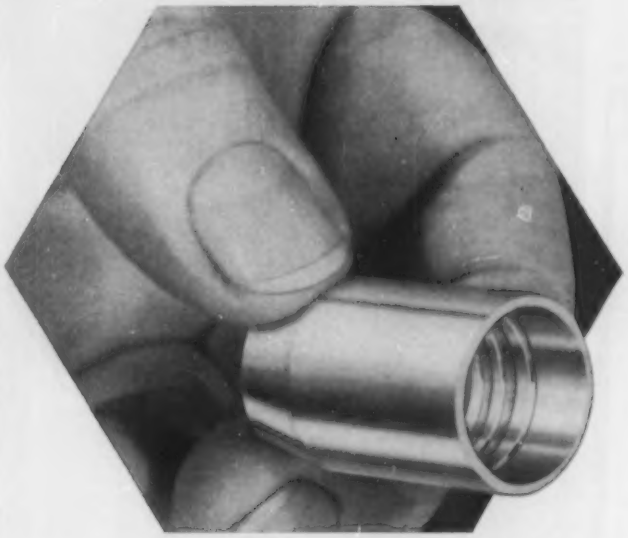

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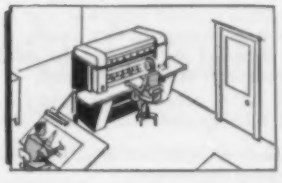

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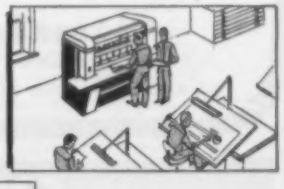

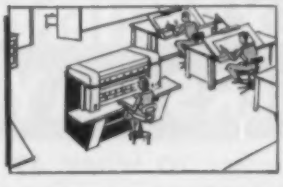

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Electronic *Mechanical*

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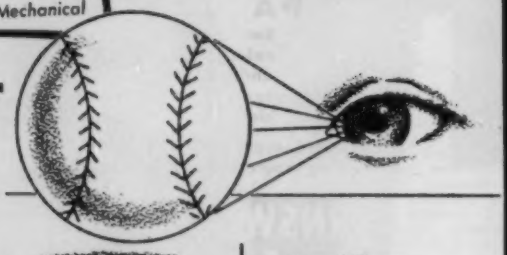

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	COMMUNICATIONS	CFO		CFO
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	COLOR TV, GAS, POWER & PHOTO TUBES	L	L	L
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	COMPUTERS	MCF	MCF	MCF
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Eng. & Plant, 30125 Groesbeck Hwy.
Roseville, Mich.

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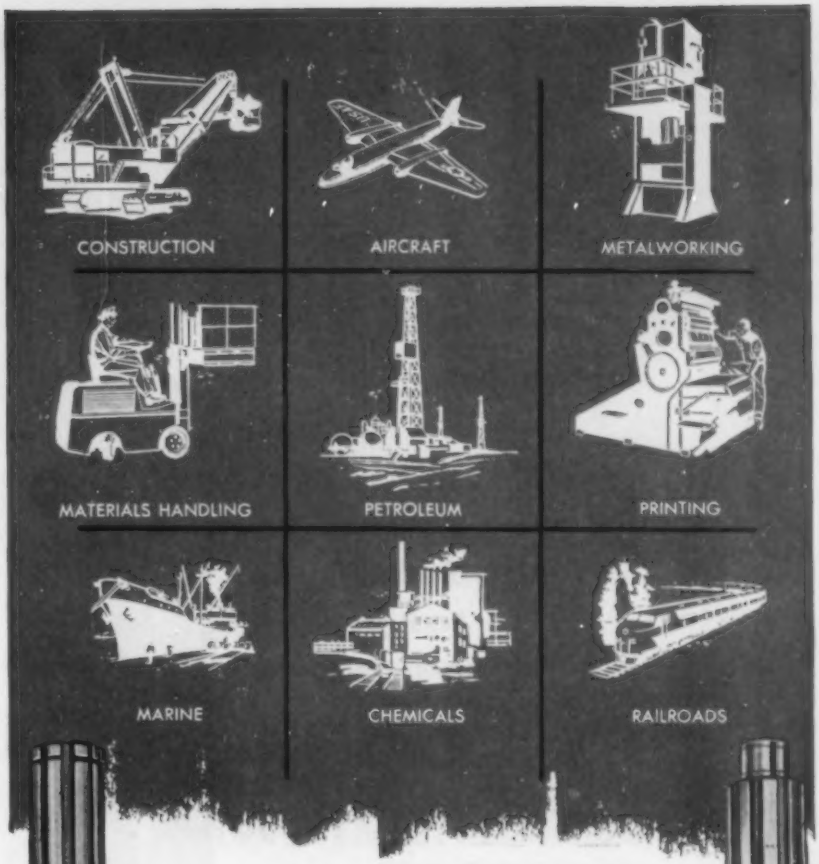

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World's foremost designer and builder of aircraft engines

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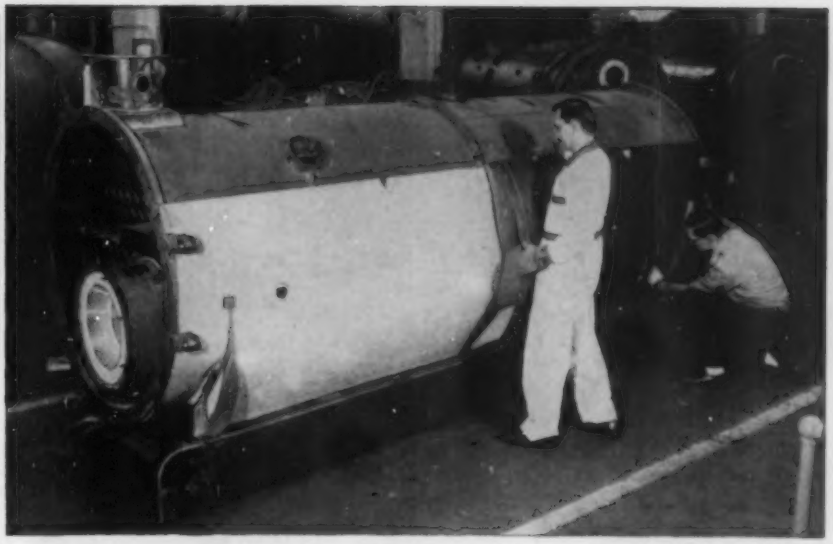
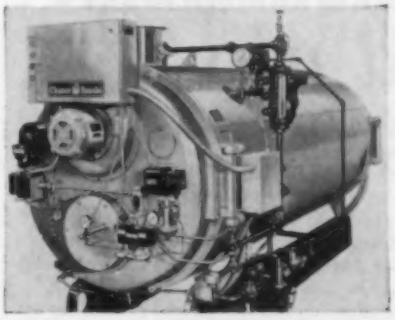


Installing Microlite insulation and lagging on a CB boiler

In **Cleaver-Brooks** self-contained boilers . . .

Microlite® insulation reduces heat loss — lowers production cost



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The high insulating efficiency of this resilient glass fiber insulation reduces heat loss; provides a cooler boiler room.

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Vibration resistance
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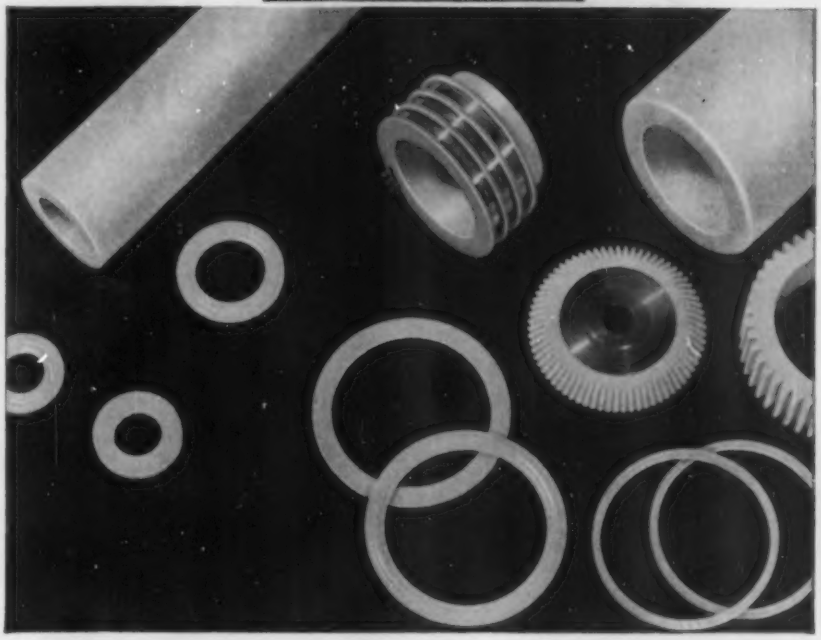
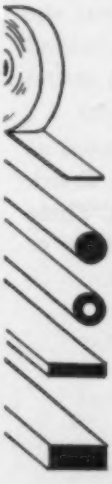
POLYPENCO® NYLON SHAPES



Cut the Cost of Nylon Parts... Machine Them From POLYPENCO Shapes

• Here's how you can produce uniform high quality nylon parts that will meet your own high standards—and at surprisingly low cost!



MACHINE FROM STANDARD SHAPES

POLYPENCO Nylon comes to you in standard shapes of rod, strip, tubing, tubular bar and slab. From these stock shapes it's a quick and economical step to make your own gears, bushings, bearings, cams and other parts—thus eliminating the extra cost of molding dies.

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*DU PONT TRADEMARK

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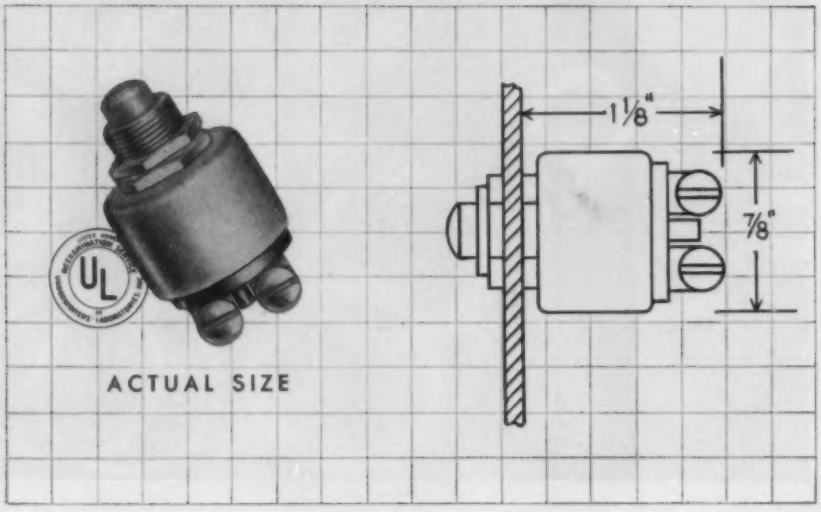
Panel Mount Push Button Switch



Model "D" ACRO micro-switch

A PRECISION SNAP ACTION SWITCH IN CONVENTIONAL PUSH BUTTON STYLE

Precision switches come in all shapes and sizes. Here's an important new one by Acro that rounds out the line. Its compact dimensions conserve space behind the panel. And installation is a cinch since round holes are easiest to cut.

This little switch packs a big wallop! It's rated at 12 amps, 125 volts, ½ hp—Underwriters' listed. Mechanically, there's up to 3/16 inch overtravel. Three types of terminals are available—screw, solder or quick disconnect.

Write for Data Sheet D-1

ACRO SWITCH DIVISION

ACRO MANUFACTURING COMPANY

COLUMBUS 16, OHIO

Plants at Columbus and Hillsboro, Ohio

REPRESENTATIVES IN ALL PRINCIPAL CITIES

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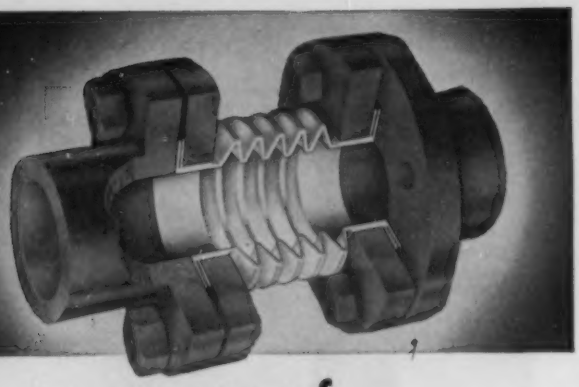

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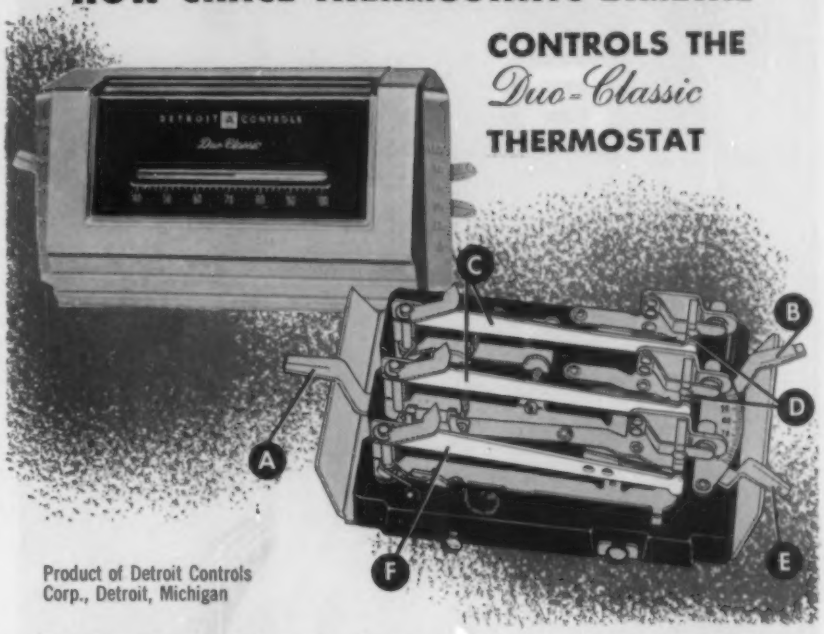
HOW CHACE THERMOSTATIC BIMETAL CONTROLS THE *Duo-Classic* THERMOSTAT



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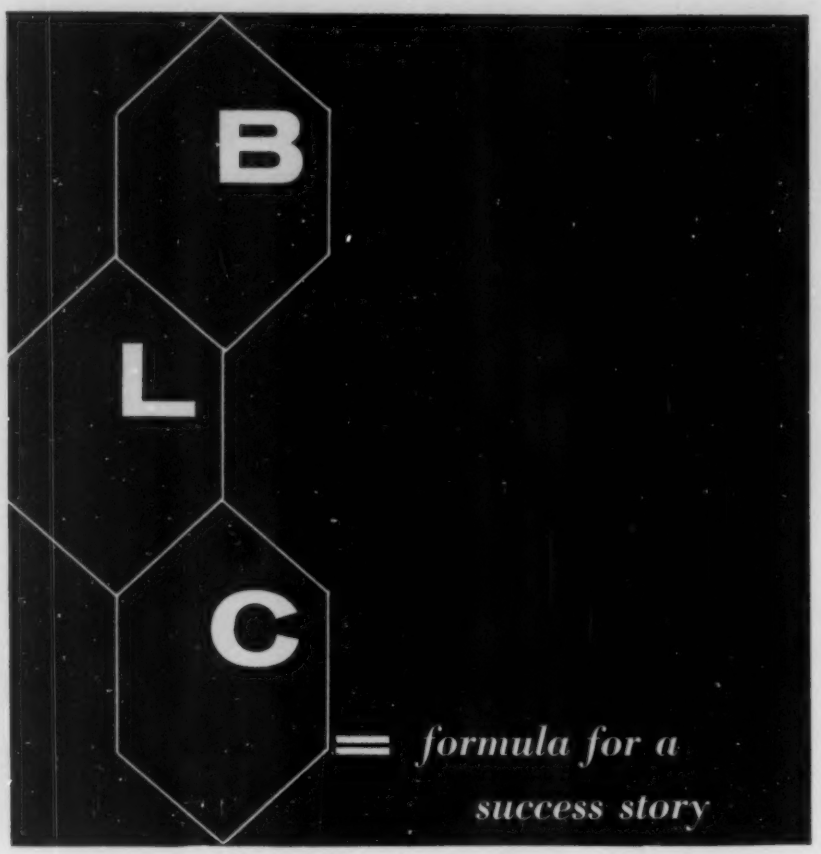

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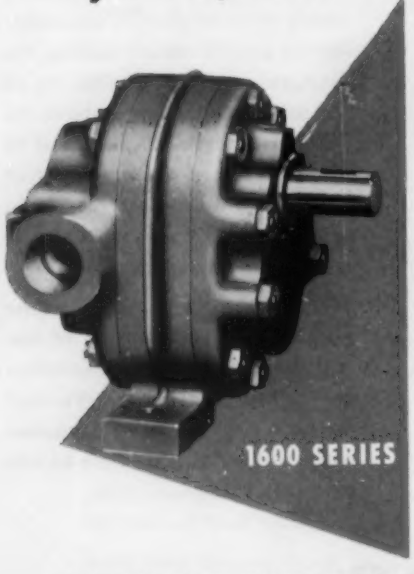

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NOW!

through-shaft magnetic disc brakes with solenoid advantages

Now you can drive off both ends of a motor shaft and still take advantage of the quick-stop, instant-release features of a Stearns solenoid-type magnetic disc brake. This new brake is designed so that the motor shaft extends right through the center and out beyond the end of the brake. For motor manufacturers this permits use of a standard length shaft for Stearns brakes mounting on NEMA frames 56-C, 66-C, 182 and 184. For design engineers it means utilization of both ends of the shaft, no matter what your drive needs.

Just as important, you get all the advantages of the popular Stearns solenoid-type brake in this through-shaft construction:

Easy maintenance — Stearns solenoid brakes have a minimum number of parts — can be disassembled and assembled in a few minutes. Long-lasting lining easily replaced.

Easy adjustment — quick, accurate adjustment for torque and lining wear.

Fast stop — positive spring action on pressure plates. Sets automatically in case of power failure.

Quick release — instantaneous magnetic pull eliminates drag.

Dust and water-resistant housings available.

See your Stearns representative or write us for full details on this new through-shaft brake.

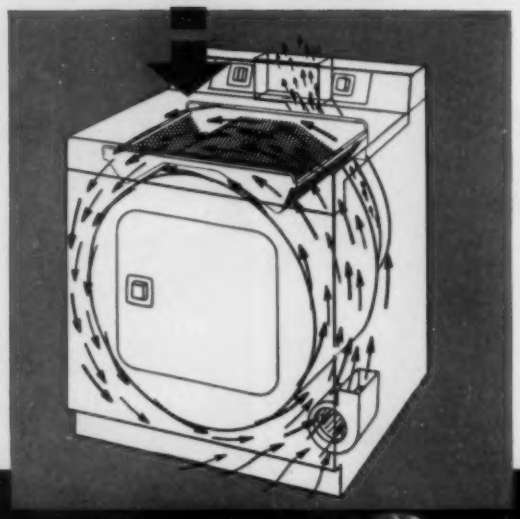
1141

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th Street, Milwaukee 46, Wis.

How EXPANDED METAL helps dry delicate fabrics



Besides a tumble-dryer for normal laundry, the Rheem-Wedgewood clothes dryer has an exclusive *clothes-saver* feature. In this special compartment, formed from Penmetal expanded metal, precious nylons, fragile woolens and delicate synthetic fabrics may be dried safely in low temperature—without tumbling.

Penmetal expanded metal is ideal material for the *clothes-saver*. It is easily formed and welded; the strands are so smooth they will not damage delicate fabrics; and the open mesh allows the "fluff-breeze" to circulate freely. The diamond truss pattern adds strength to the metal; looks attractive, too, when the lid is up. Yet, Penmetal expanded metal is low in cost.

Penmetal expanded metal is available in carbon steel, aluminum, stainless steel, Monel, Inconel, and other metals. Large or small mesh. Light or heavy gauge.

Why not investigate? Penmetal expanded metal could provide a step toward a better product. Send for 28-page catalog which suggests uses for expanded metal, and gives mesh sizes, weights and dimensions.

PENN METAL COMPANY, INC.
General Sales Office:
205 East 42nd Street, New York 17, N. Y.
Plant: Parkersburg, W. Va.

These Palmaire electric heaters have Penmetal expanded metal grilles, with baked enamel finish. Made by Palmer Mfg. Corp., Phoenix, Arizona.

PM-70

NEW 3-POINT EASY-TO-USE

READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalog and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key number in the space indicated. Bulletins are described on pages 290–297.

To get more data about new Components, Materials and Parts fully described on pages 214 to 289, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T–Top; B–Bottom; R–Right; L–Left; TL–Top left; BL–Bottom left; TR–Top right; BR–Bottom right.

For specialized data . . . price, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

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NEW PRODUCTS... Description of these new engineering materials appear on pages 214-289. Circle key number for more data.

1—Rubber Molded Continuously
2—Variable Speed A-c Motor
3—Plastic Coated Wire Rope
4—Governor With Changeable Weights
5—Tape Potentiometer
6—Interlocking Hole Liners
7—Friction Power Take-Off
8—Clutch for Power Transmissions
9—Ball and Disk Integrator
10—Lock Nut Also Seals
11—Lubrication for Pneumatics
12—Panel Fastener
13—Threaded Bolt Spacer
14—Plastic Cable Clamp
15—Balls of Nickel Alloys
16—Conveyor Wheels
17—Non-Lubricated Pulley
18—Socket-Head Set Screws
19—Air-Powered Vise
20—Anchor Nut in 2-56 Size
21—Split-Type Roll Bracket
22—Levers From Standard Forgings
23—Single End Magnetic Clutch
24—Magnetic Amplifier
25—D-c Signal Voltage Control
26—Miniature Magnetic Clutch
27—Totally Enclosed Fhp Motors
28—Thumb-Sized Servo Motor
29—Totally Enclosed Fan-Cooled Motor
30—Servo-Actuator Motor Package
31—Permanent Split Capacitor Motor
32—Shorter End-Mounted Motors
33—Low-Speed Synchronous Motors
34—Mobile A-c Power Unit
35—Fan Motors ¾ to 20 Hp
36—Four-Cycle, Heavy Duty Engine
37—Non-Ventilated Brake Motor
38—Subminiature Motor Generator
39—Regulated D-c Power Supply
40—Dual Power Supply
41—Hydraulic Power Units
42—Klystron Power Supply
43—Control Transformers
44—Voltage Ratio Transformers
45—High-Impedance Transformers
46—Power Transformers
47—Time Delay Relay
48—Plug-In Relays
49—High-Speed Clutch Controls
50—Heavy Duty Relays
51—Time Delay Relays
51A—Heavy-Duty, Low-Force Switch
52—Printed Circuit Relay
53—Miniature Motor Overload Switch
54—Miniature Power Relay
55—Sine Curved Snap Switch
56—Universal Counter-Timer
57—Environment-Proof Switches
58—Low Torque Selector Switch
59—Rotary Switch
60—Heavy Duty Limit Switch
61—Cold Cathode Tube
62—Electric Impulse Counter
63—Ruggedized Meter-Relay
64—Plastic Front Instruments
65—Potentiometer
66—Nylon Wire Insulators
67—Gold-Bonded Germanium Diodes
68—High Resolution Potentiometers
69—Precision Ganging Potentiometers
70—Vitreous-Enameled Resistors
71—High Current Wire Grid Resistors
72—Ceramic Feed-Thru Capacitor
73—Subminiature Ceramic Capacitor
74—Miniature Pressure Transducers
75—Polystyrene Capacitors
76—Drawn Oval Capacitors
77—Dipped Mica Capacitor
78—Capacitors Operate to 150 C
79—Thermostats
80—Power Actuator
81—Precision Tape Feed Assembly
82—Woven Heater Elements
83—Oil-Tight Indicator Lights
84—Sub-Miniature Radio Noise Filter
85—Measures Pulsating Fluid Flow
86—Adjustable Machine Control Arm
87—Microminiature Cable
88—Silicon Voltage Reference Diodes

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USE THIS SPACE TO INDICATE REQUIRED.....

89—"Thin-Package" Linear Actuators
90—Surface Speed Indicator
91—High Frequency Ignition
92—Subminiature Centrifugal Blower
93—Hydraulic Temperature Probe
94—Portable Compressor
95—Foot-Operated Valve
96—Adjustable Bypass and Restrictor
97—Ecliptic Valve
98—Drain or Sampling Valve
99—Check Valve for 3,000 psi
100—Electrical Power Cylinder
101—Depth Control Cylinders
102—Rotating Hydraulic Cylinder
103—Removes Waste From Air Tanks
104—Pneumatic-Hydraulic Cylinder
105—Square-End Air Cylinders
106—Gas Charging Valve
107—Fitting For Instrument Tubing
108—Hydraulic Tube Fittings
109—Plastic Extrusions with Foil
110—Isothane Foaming System
111—Large Diameter Rod and Tube
112—Cross-Linked Vinyl Coatings
113—Centrifugally Cast Nylon Tubes
114—Asbestos Sheet Packing
115—Plastic Sandwich Panel
116—Plastic Foam Materials
117—Slide Rule Spring Computer
118—Transfers Provide Patterning
119—Pocket Slide Rule
120—Transient Force Recorder
121—Whiteprinter Operates At Up to 70 fpm
122—Measurement of High Resistance
123—Printed Circuit Design Kit
124—Portable Electronic Counter
125—Sound Level Meter
126—Bridge Amplifier and Meter
127—Oscilloscope Camera
128—High Voltage Power Supply
129—Three-Phase Power Supply
130—Regulated Power Supply
131—High Temperature Accelerometers
132—Strain Gage Power Supply
133—Hardness Tester
134—Regulated D-c Power Supply
135—Measures Accelerations
136—Pictorial View While Drafting
137—Mechanical-Electronic Kit

... PRODUCTS ADVERTISED

... NEW PRODUCTS . . .

... NEW BULLETINS . . .

... SPECIFIC DATA . . .

NEW BULLETINS . . . listed below are described on pages 290-297. Circle key number for your copy.

138—Lock Washers
139—Teflon Products
140—Seamless Stainless Tubing
141—Wire Cloth
142—Industrial Papers
143—Universal Joints and Shafts
144—Electrically Operated Valve
145—Stainless Steel Weld Deposits
146—Ruggedized Instruments
147—Two-Circuit Limit Switch
148—Magnetic Components
149—Flexible Metal Hose
150—Hermetic Seal Connector
151—Vibration Isolation
152—Polyethylene Sheeting
153—Photocopy Paper
154—Casters and Wheels
155—Stainless Steel
156—Electrical Quick-Disconnect
157—Hydraulic Quality Steel Tubing
158—Solenoid Valves
159—Photographic Film
160—Gears
161—Electrical Controls
162—Thermostat Bimetal
163—Zinc Coatings and Anodes
164—Heavy Metals
165—Flow Regulation and Control
166—Gears
167—Set Screws
168—Three-Dimensional Cams
169—Woven Heat Elements
170—V-Belts
171—Solenoid Valves
172—Voltage Regulators
173—Spring Design
174—Hose Couplings
175—Hydraulic Pumps
176—Drafting Equipment

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177—Glass Fiber Filters
178—Strainers
179—Variable Speed Drive
180—Worm Gearmotors
181—Automatic Valve Positioner
182—Alkyd Molding Compounds
183—Engineering Research Development
184—Valves, Fittings, Accessories
185—Polar Relay
186—Flexible Couplings
187—Electrical Connectors
188—Fans and Blowers
189—Tool Steels
190—Stainless Wire, Rod, Strip
191—Ball and Roller Bearings
192—Relays

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Requests for information made through *Product Engineering* Readers' Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

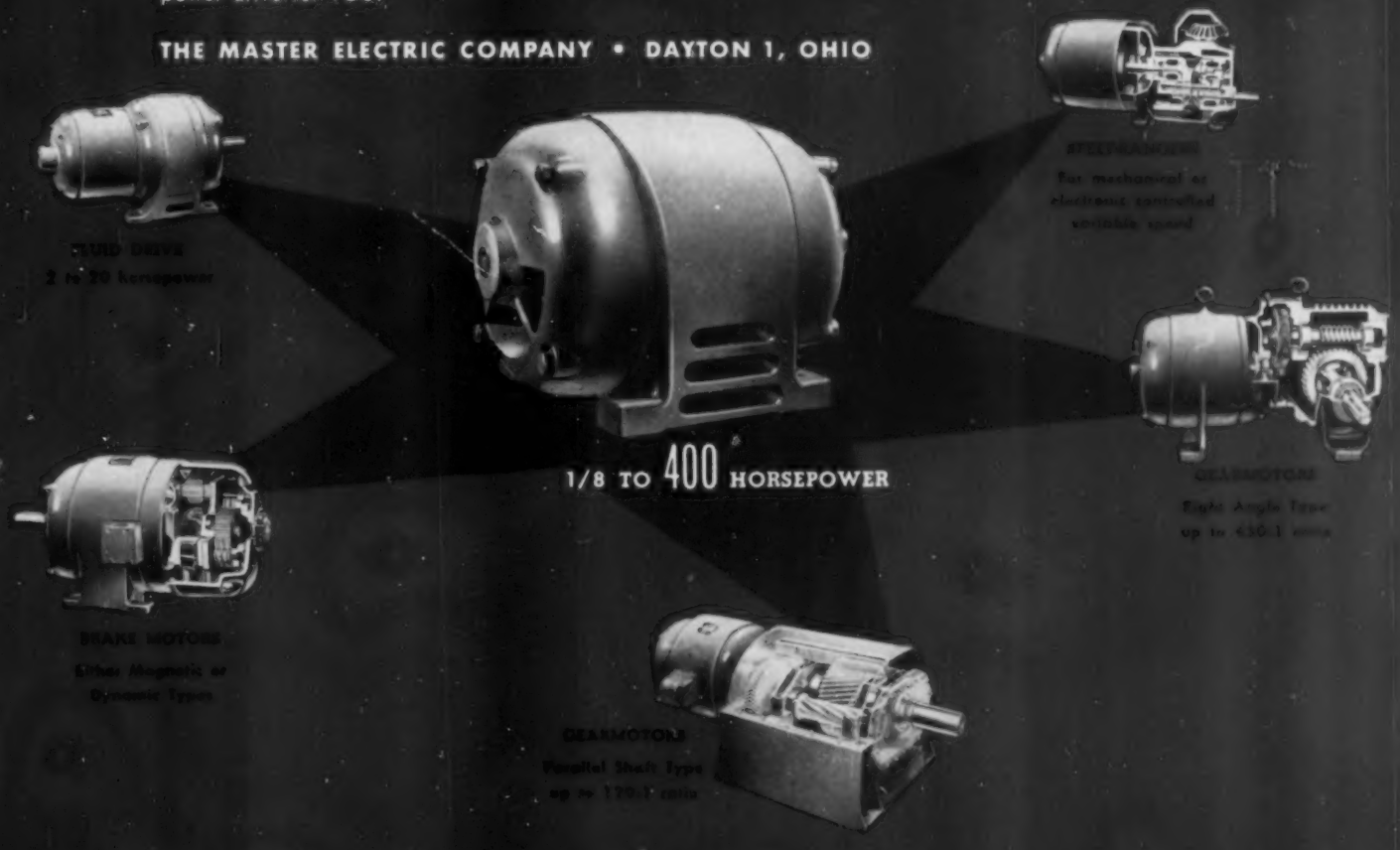
Whenever you select a power unit, don't put a straight-jacket on your ideas . . . consider ALL of the possibilities of modern power drives.

For example consider the many useful combinations that can be secured with the basic Master power units shown below. They're designed so they can be easily combined together to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features in one compact unit that you can use RIGHT where you want it. Nowhere else will you find power units that are so flexible, so easily adaptable, and in such a wide range of types and ratings.

Master power drives are available in thousands and thousands of ratings (1/8 to 400 HP) . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for YOU.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

give your brains a chance



Trepans and bores 32-foot gun barrels—TIMKEN® bearings keep huge spindle accurate

THIS Baldwin-Lima-Hamilton NILES A36B boring lathe has a finished weight of 235,680 lbs. and an overall length of 90 feet. It took one year to build and was specifically made to trepan and bore gun barrels as long as 32 feet. To give its huge spindle high accuracy and stability—despite heavy radial and thrust loads and speeds up to 1000 R.P.M.—the spindle was mounted on Timken® tapered roller bearings.

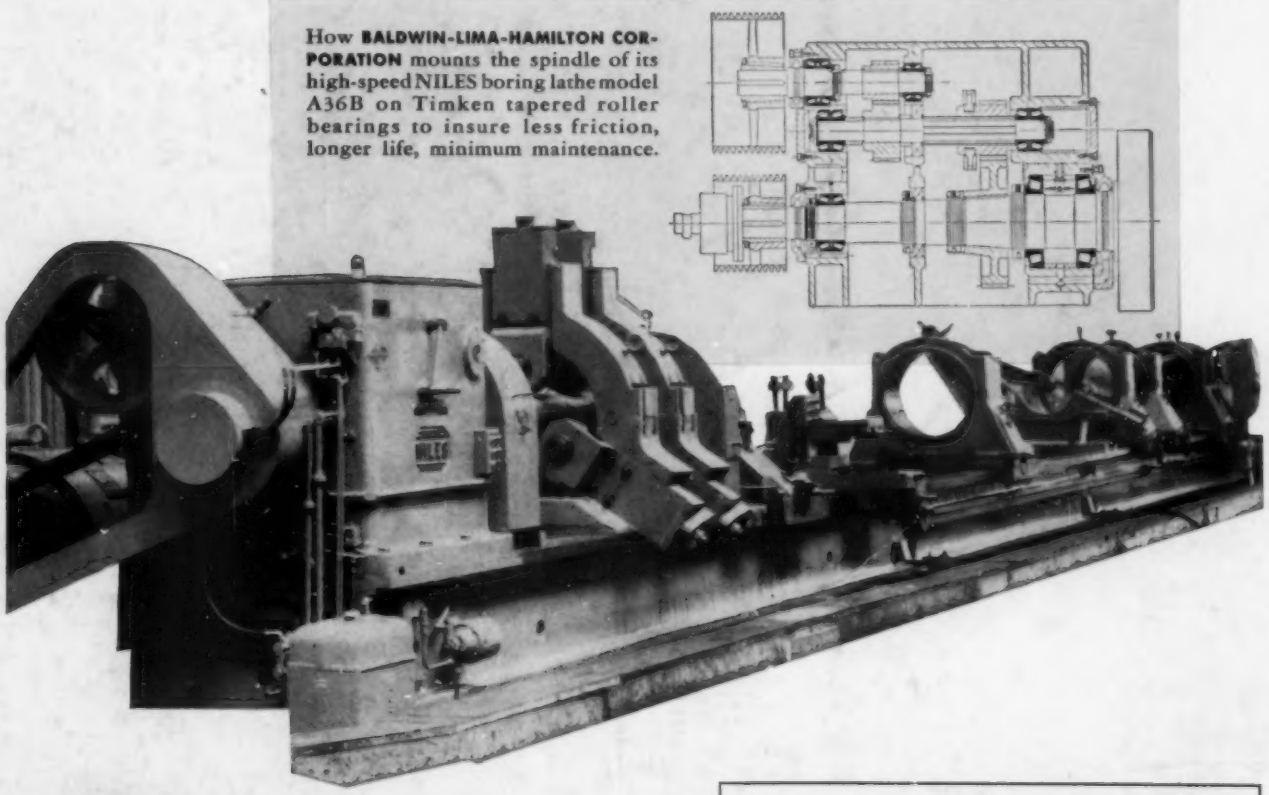
Timken bearings are tapered in construction to take the heavy radial *and* thrust loads this huge spindle gets. Full line contact between rollers and races provides maximum capacity. They maintain spindle precision and accurate gear mesh.

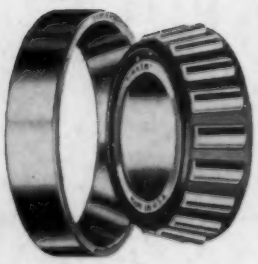
Timken bearings reduce wear because they practically eliminate friction. That's because they're designed by geometrical law to have true rolling motion and made with extreme accuracy so they live up to their design. And they're made of steel we make ourselves: we're the only U. S. bearing maker who takes this extra quality precaution.

Specify Timken bearings for the machinery you build or buy. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

How **BALDWIN-LIMA-HAMILTON CORPORATION** mounts the spindle of its high-speed NILES boring lathe model A36B on Timken tapered roller bearings to insure less friction, longer life, minimum maintenance.





TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

DON'T MISS THE TIMKEN BEARING DISPLAY

You'll want to see The Timken Roller Bearing Company display at the Production Engineering Show, booths 425 and 426, September 6 through 16, Navy Pier, Chicago.

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION